MAY · 1950

electronics

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ULTRA COMPACT
Portable . . . High Fidelity

OUNCER
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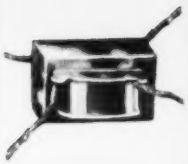
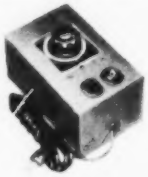


SUB OUNCER
Weight ⅓ ounce

COMMERCIAL GRADE
Industrial Dependability

SPECIAL SERIES
Quality for the "Ham"

POWER COMPONENTS
Rugged . . . Dependable



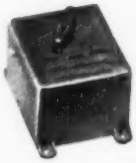
VARITRAN
Voltage Adjustors

MODULATION UNITS
One watt to 100KW

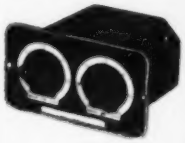
VARIABLE INDUCTOR
Adjust like a Trimmer

TOROID HIGH Q COILS
Accuracy . . Stability

TOROID FILTERS
Any type to 300KC



MU-CORE FILTERS
Any type ½ – 10,000 cyc.



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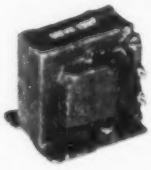
Broadcast & Sound

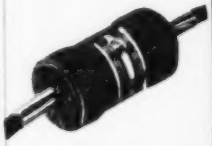
PULSE TRANSFORMERS
For all Services

HERMETIC COMPONENTS
Ceramic Terminals

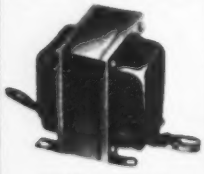
PLUG IN ADAPTER
Impedance Matching



FOSTERITE
Grade 3 JAN Components



CABLE TYPE
For mike cable line



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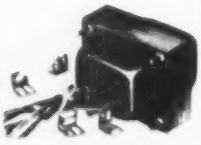
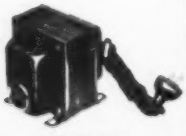
Husky . . . Inexpensive

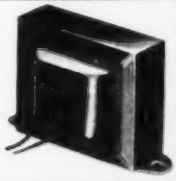


REPLACEMENT
Universal Mounting



STEP-DOWN
Up to 2500W . . . Stock

LINE ADJUSTORS
Match any line voltage



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AUTOMATIC EXPOSURE CONTROL ..... Cover

Capitol Hill, Albany, N. Y., from photo-reconnaissance plane. Camera equipped with electronic servo aperture control practically eliminates human element (see p 74)—*Photo USAF*

ELECTRONIC MACHINES FOR BUSINESS USE, by W. B. Floyd 66

A potential customer tells what sort of machines are needed in the average office

VIDICON—PHOTOCONDUCTIVE CAMERA TUBE, by P. Weimer, S. Forgue, R. Goodrich 70

Simplified design of camera equipment is possible with this small, sensitive pickup tube

AUTOMATIC EXPOSURE CONTROL, by G. Bruck, J. Higgins, and J. Ward 74

Fast automatic aperture control for aerial camera uses latest photoelectric and servo techniques

BOWLING-ALLEY FOUL DETECTORS, by E. Jellinek 79

Photoelectric system suitable for league competition under ABC rules

ANTIFADING BROADCAST ANTENNA, by H. Brueckmann 82

Broadcast service area increased by inserting insulator midway and feeding antenna at that point

IMPROVED SPEECH INVERTER SYSTEM, by Leslie L. Koros 86

Secrecy circuit for radio or telephone has improved noise and distortion characteristics

INDUCTANCE METER, by J. M. Marzolf 90

Inductance values from 5 mh to 100 henrys are readily measured

TELEVISION SYNCHRONIZING GENERATOR, by G. Zaharis 92

Standard RMA sync signals from equipment based on flip-flop circuits with only one adjustment

PHASE-SHIFT BAND-PASS FILTERS, by D. H. Pickens and J. N. Van Scoyoc 96

Technique permits use of standard inexpensive components

CALIBRATING STRIP-TYPE DIALS, by F. W. Schramm 100

Accurate 2-kc markers, from 50 to 3,500 kc, are printed on a 40-foot film strip

BROAD-BAND TELEVISION TUNERS, by Arnold Newton 102

Several extremely compact and economical circuits are described in detail

GAMMA-RAY RADIATION MONITOR, by Leonard Reiffel 107

Self-switching circuit covers voltage range of 100,000 to 1

VTVM CIRCUITS, by Myron C. Selby 110

Survey of characteristics of eight fundamentally different basic circuits

THE TRON FAMILY, by W. C. White 112

Alphabetical listing of words bearing the suffix *tron*, with definitions

BUSINESS BRIEFS	60	ELECTRON ART	120	NEW BOOKS	132
CROSSTALK	65	NEW PRODUCTS	124	BACKTALK	132
TUBES AT WORK	116	NEWS OF THE INDUSTRY	128	INDEX TO ADVERTISERS	(Last Page)

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ELECTRONICS: May, 1950, Vol. 23; No. 5. Published monthly, with an additional issue in June, price 75¢ a copy for U. S. and possessions, and Canada: $1.50 for Latin America: $2.00 for all other foreign countries. Directory issue $2.00. Allow at least ten days for change of address. All communications about subscriptions should be addressed to the Director of Circulation. Subscription rates—United States and possessions, $6.00 a year, $9.00 for two years, $12.00 for three years. Canada (Canadian funds accepted), $10.00 a year, $18.00 for two years, $25.00 for three years. Latin American countries $15.00 for one year, $25.00 for two years, $30.00 for three years. All other countries $20.00 for one year, $30.00 for two years, $40.00 for three years. Please indicate position and company connections on all subscription orders. Entered as Second Class matter August 29, 1936, at Post Office, Albany, New York, under the act of March 3, 1879. BRANCH OFFICES: 520 North Michigan Avenue, Chicago 11, Ill.; 68 Post Street, San Francisco 4; Aldwych House, Aldwych, London, W.C. 2; Washington, D. C. 4; Philadelphia 3; Cleveland 13; Detroit 26; St. Louis 8; Boston 16; Atlanta 3, Ga.; 621 So. Hope St., Los Angeles 14; 7350 Oliver Building, Pittsburgh 22. ELECTRONICS is indexed regularly in The Engineering Index.

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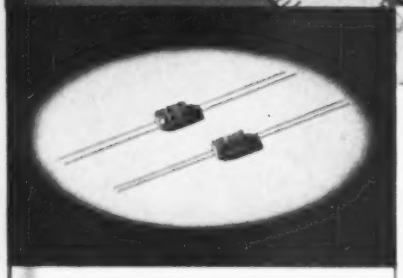

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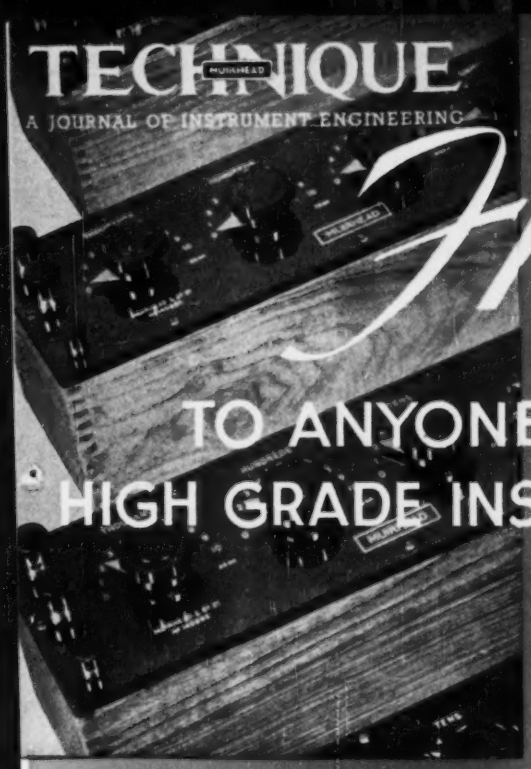

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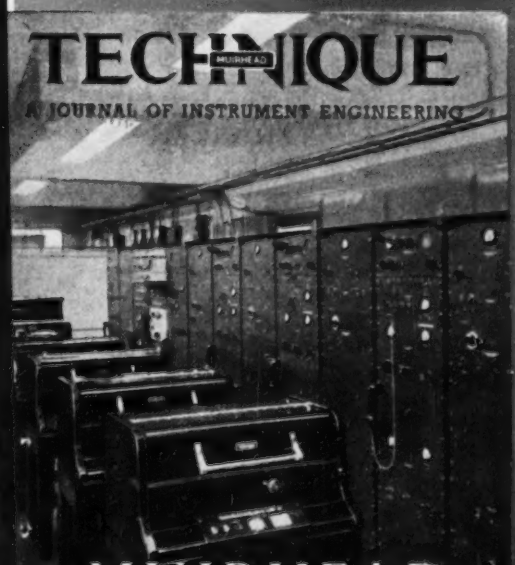

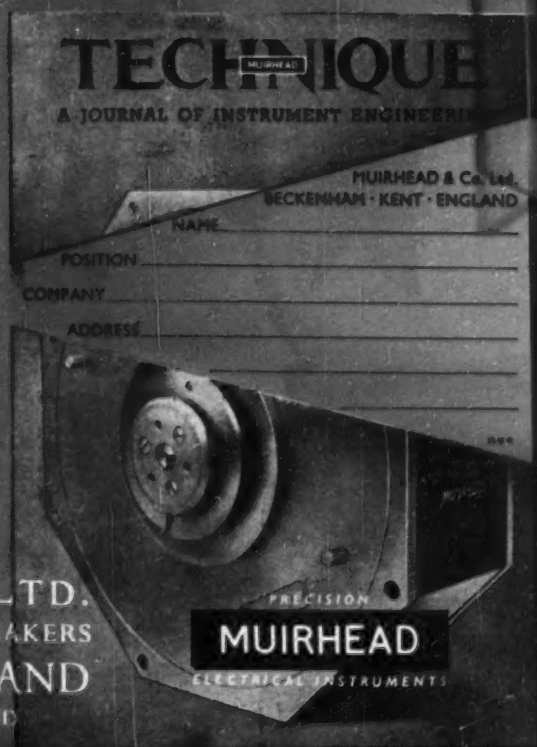

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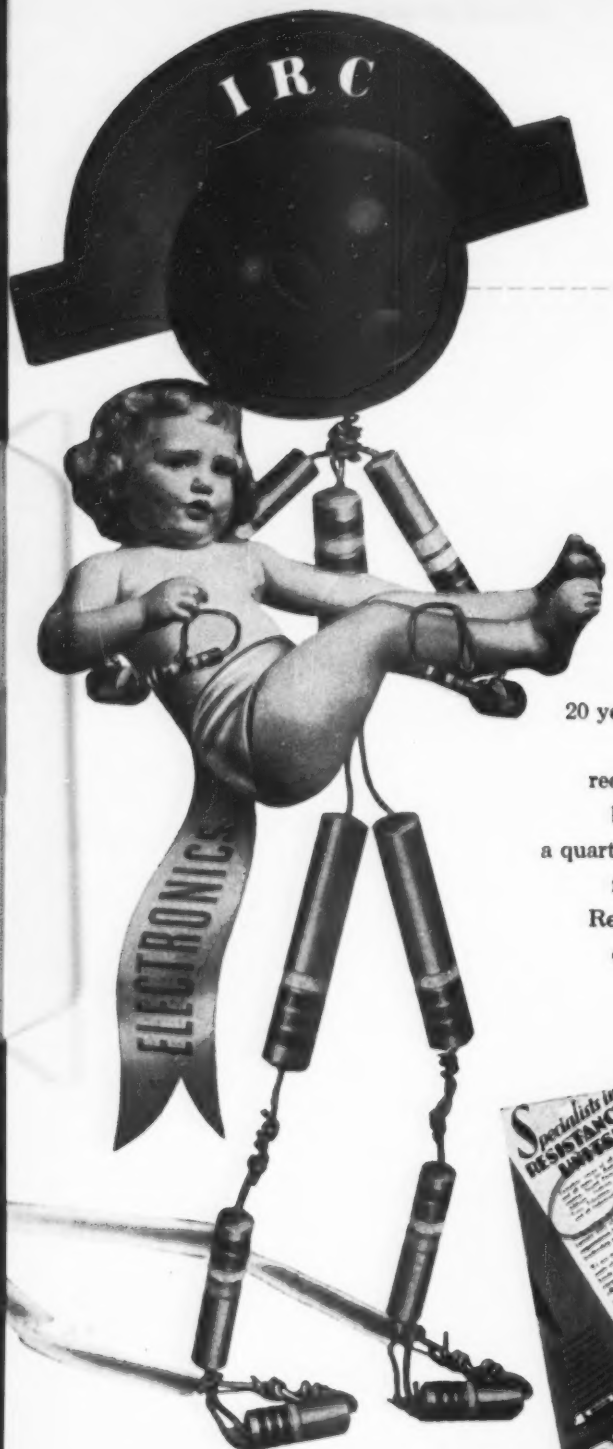

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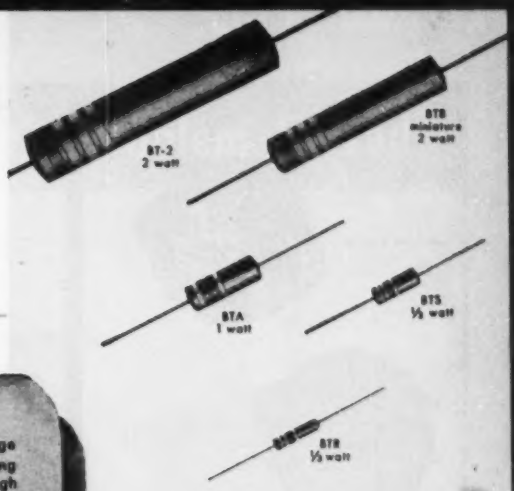

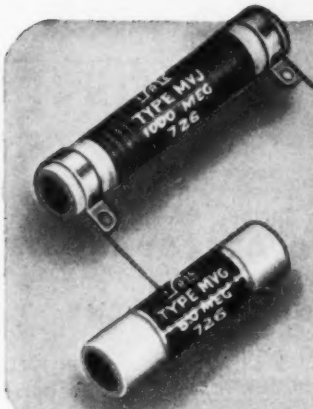

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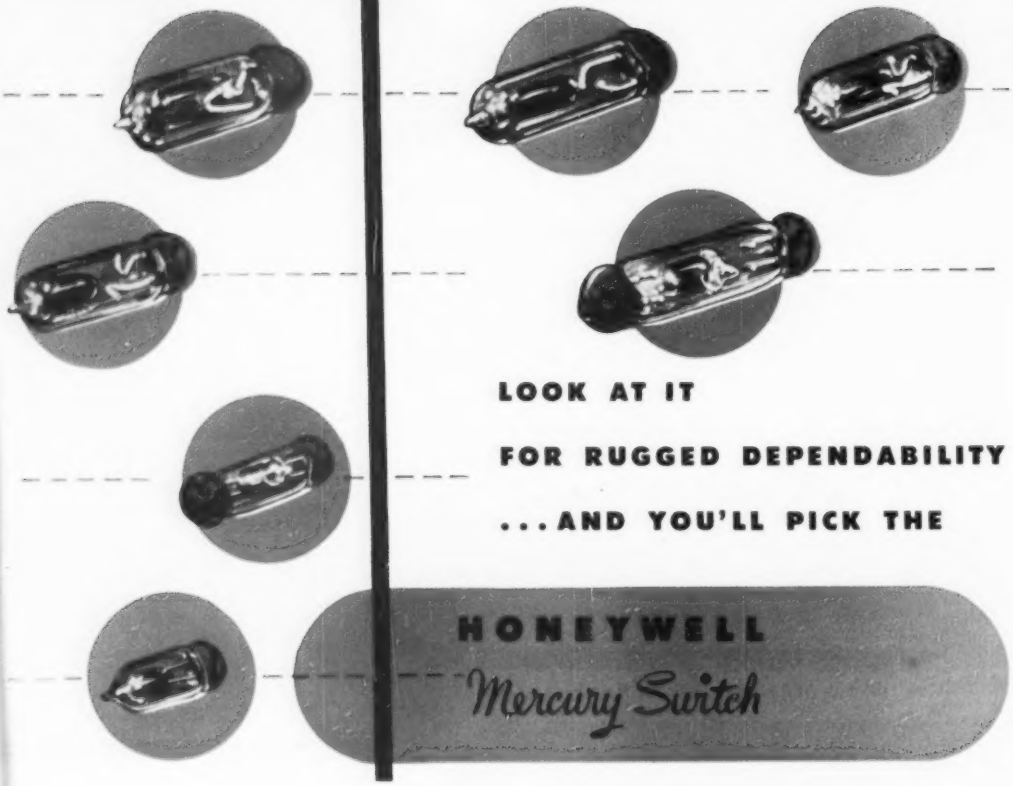

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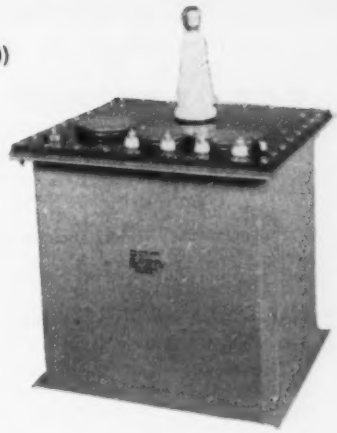

PROBLEM: To design a 60 cycle power supply to the following specifications:

Input voltage:	117VAC
Output voltage:	50 KV
Output current:	1 ma (at 50 KV)
Output ripple:	less than 1%
Output regulation:	4000 volts per milliampere
Altitude:	7500 feet
Temperature and humidity:	Indoor conditions, U.S.A.
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Size:	less than 2 cubic feet

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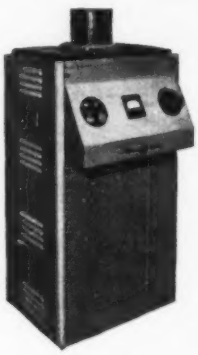

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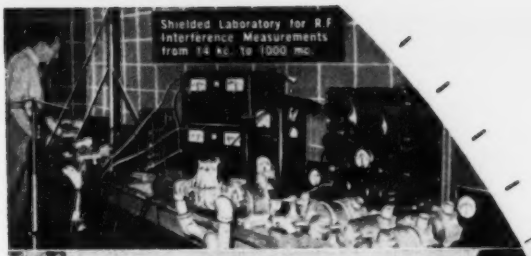

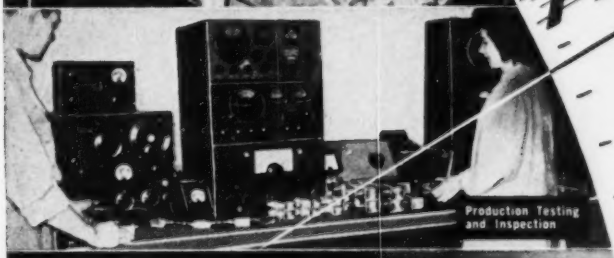

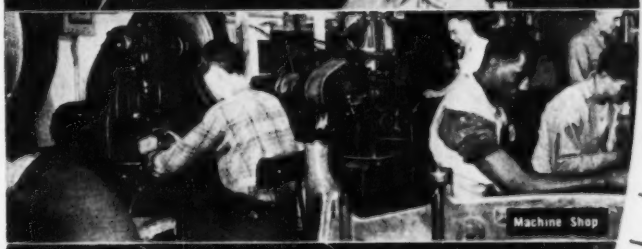

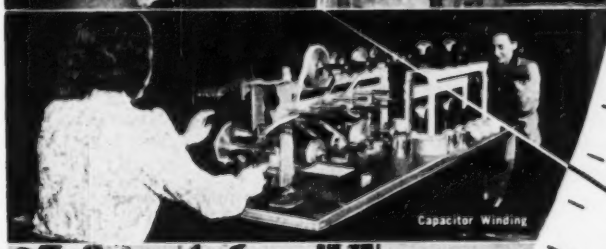

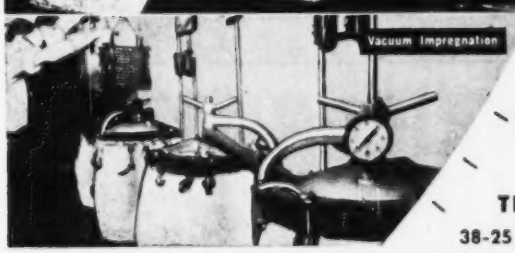

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in

- **QUALITY**
- **PRODUCTION**
- **ENGINEERING**

FILTRON'S COMPLETE FACILITIES: capacitor manufacturing, coil winding, stamping department, tool and die shop, and assembly department, together with its Engineering and Research laboratories insures quality production and ON SCHEDULE DELIVERY.

FILTRON'S *advanced* engineering, due to constant research and development by engineers with years of R.F. INTERFERENCE experience has resulted in *smaller, lighter,* and more *efficient* R.F. Interference Filters.

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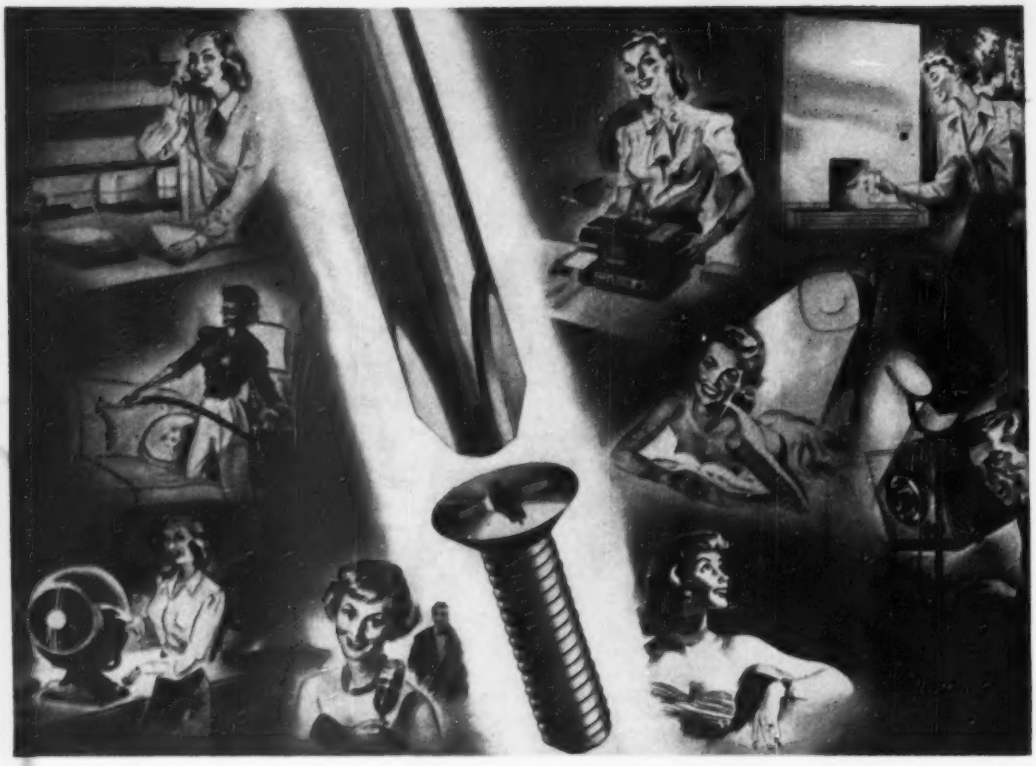

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HOW THEY CUT COSTS: From vacuum cleaners to vending machines; from trucks to office appliances and suntan lamps . . . manufacturers use American Phillips Screws to speed up production, stop spoilage, and cut unit-costs. For these modern fastenings banish fumbling, crooked driving and scarred surfaces . . . *cut assembly time as much as 50%.*

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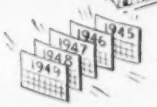
How many times have your design engineers been called upon to develop new equipment only to be faced with a new bug — or special problem of one variety or another? Everything about the new gadget seems but you need a special part to lick the special problem. To Centralab Engineers these queer bugs and special problems are as welcome as a Rolls Royce to a burlesque queen They look on these problems as their own and from their bag of 30 years of electronic experience — they always come up with an answer. Take a look over the next two pages . See for yourself some of these "Specials" in ceramics, switches and capacitors that CRL has developed to meet special needs during the past few years  . Maybe you'll see one that can help — or you'll know where to go with your next special problem. of course!

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MAY 1950

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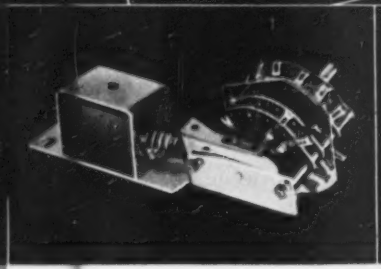
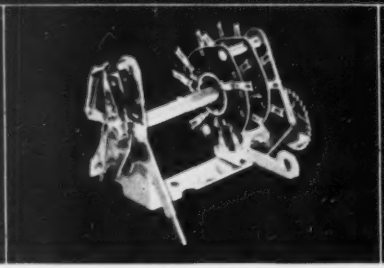
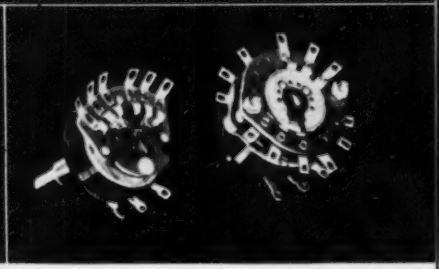
If you have an unusual electronic or ceramic part design and fabrication problem — bring it to Centralab. It may very well happen that with a combination of standard CRL parts — or a slight modification thereof — we can help you solve it. If special requirements warrant — we can design a completely new unit and produce it for you. All we need is your exact requirements as to purpose, size, capacity, voltage and resistance. Write Dept. "E" outlining your problem. No obligation. Centralab Division, Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wisconsin.



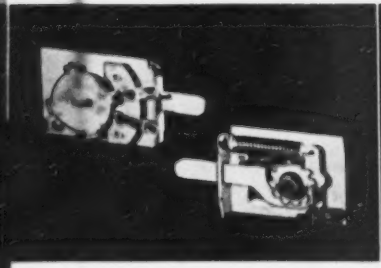
1 A solenoid operated selector switch.



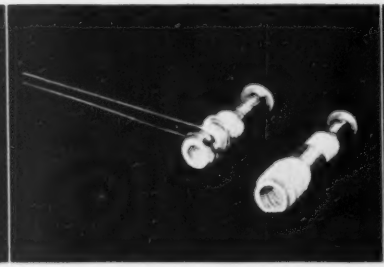
2 Automatic selector switch for automobile radio.



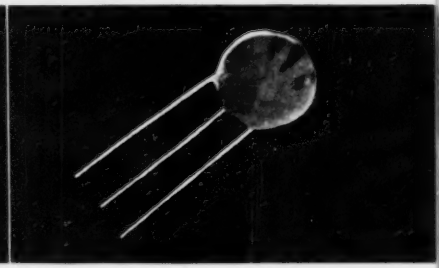
3 Combination control and selector switches.



4 Front and rear view — push button type tone switch.

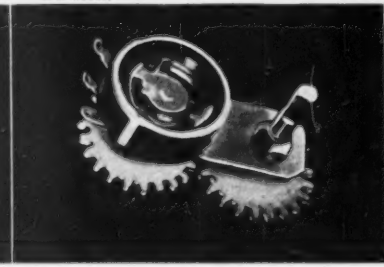


5 Left — dual TV Trimmer. Right — TV trimmer combined with ceramic coil form.

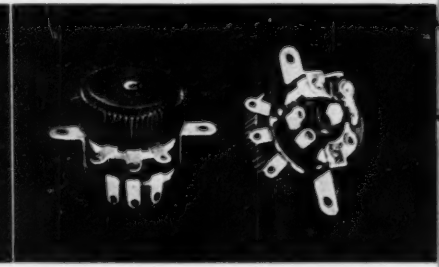


6 5000V dual disc ceramic capacitor. Actual size, slightly larger than a nickel.

7 Special tubular ceramic capacitor — 2200 MMF ± 1%.

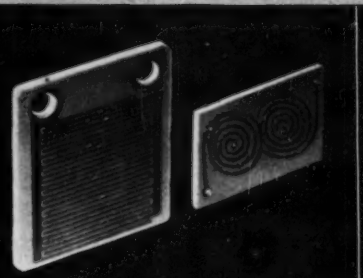


8 Control with offset shaft and operating gears.

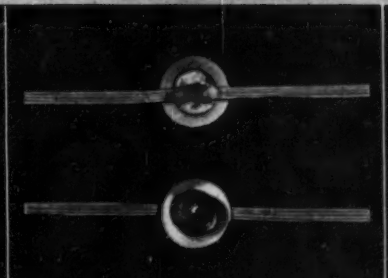


9 Front and rear view — Centralab's miniature (smaller than a dime!) Dual Model 1 Control.

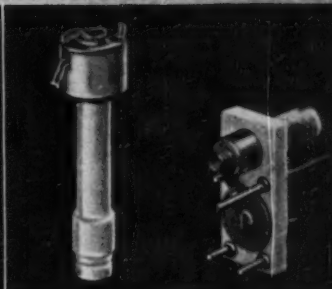
Special Electronic Parts?



10 Examples of special "printed circuit" parts. Left — a fixed value capacitor. Right — an inductance coil.

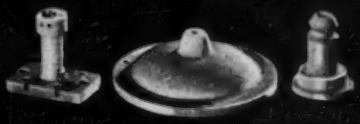


11 Front and rear view — special type by-pass capacitor.

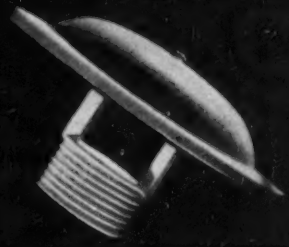


12 Special ceramic coil form and trimmer assembly.

13 Steatite ceramic coil form with bonded metal end.

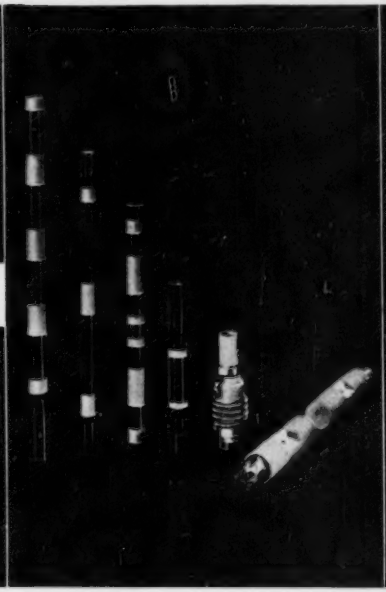


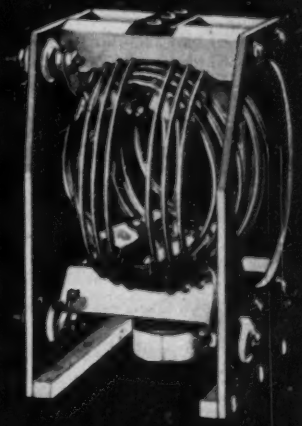
14 Centralab Steatite ceramic used in special forms — coils etc.

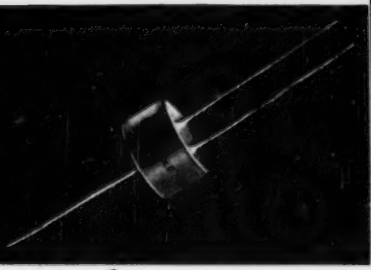


15 CRL Steatite used as part of diffusion system in hot water heater.

16 Special feed-thru by-pass capacitor.







17 Special 5-10 KV hi-voltage capacitor.

18 Metallized ceramic rods for rotor sections in hi-voltage variable transmitter capacitors, and resonant lines.

19 Special antenna loading variometer.

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STROBOSCOPES

Five stock models of stroboscopes for scientific use are manufactured by General Radio Company from designs of Edgerton, Germeshausen and Grier.

These stroboscopes have flash durations from 2 to 10 or 15 *millionths* of a second . . . more than ample to 'stop' motion in almost any machinery used in Industry. They are NOT replaceable by the relatively slow speed "stroblites" or "speed lights" whose average flash duration is about ten *thousandths* of a second, ample for ordinary commercial photography but far too slow to stop motion in machinery.

The applications of G-R stroboscopes are countless. Both as electrical tachometers . . . requiring no mechanical connection to the machine whose speed is being measured . . . and as motion-stopping devices for s-l-o-w speed observation of machines in operation, these stroboscopes are widely used in the design, testing, maintenance and sale of all kinds of mechanical and electro-mechanical equipment.

Most G-R stroboscopes furnish ample light for single- and multiple-flash photography of high-speed motion.

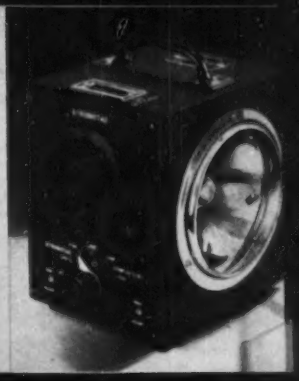
In the study and analysis of any rotating or reciprocating motion, even in the most complex machine, G-R stroboscopes provide a research and design tool whose usefulness cannot be duplicated by any other means. If you have any problem in the operation of any machine or part . . . if you'd like to see your equipment in slow motion . . . even as slow as a fraction of an rpm . . . G-R stroboscopes probably can be of inestimable value.

Our engineering department will be glad to advise you not only in the selection of the correct stroboscope but also how to use it for your particular problem.

GENERAL RADIO COMPANY

for INDUSTRY

Type 631-B STROBOTAC



The original and basic stroboscope. A small, compact, lightweight and simple-to-use device, the STROBOTAC can be operated by anyone with a few minutes practice.

The STROBOTAC contains a Strobotron neon lamp, flashes from which last only 5 to 10 *millionths* of a second. The flashing rate of the lamp is varied manually by a knob to which is attached a drum scale reading directly in rpm from 600 to 14,400. By using multiple flashes the STROBOTAC can be used to measure speed and to slow motion up to 100,000 rpm.

In addition, the Strobotac can be flashed by an external contactor, the a-c line or an oscillator.

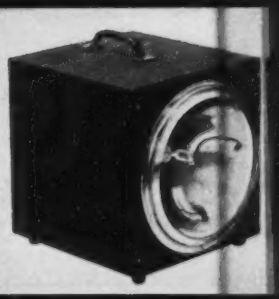
A special TYPE 631-BL STROBOTAC has an additional speed range extending down to 60 rpm for extra-slow-moving machines.

Both STROBOTACS operate directly from any 115-volt 60-cycle a-c line. Both come to you complete and ready for immediate use.

TYPE 631-B STROBOTAC (Standard model) **$125.00**

TYPE 631-BL STROBOTAC (with extra low-speed range) **155.00**

Type 648-A STROBOLUX



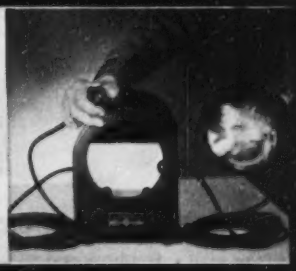
The STROBOLUX is an auxiliary light source to be used with the STROBOTAC where considerably higher light output is needed.

The STROBOLUX gives about 100 times as much light as the STROBOTAC. It is particularly useful where large areas are to be illuminated, where photography is required, and on brightly lighted surfaces. Single-flash as well as multiple-flash photographs of areas approximately 2-feet square are possible with the STROBOLUX.

The duration of each flash is 10 to 15 millionths of a second at normal speeds and about 30 millionths at low speeds and for single flashes. The multiple flashing rate is up to 6000 per minute. The accuracy is that of the STROBOTAC.

TYPE 648-A STROBOLUX **$205.00**

Type 1532-A STROBOLUME



The STROBOLUME is an extra-high-intensity light source for use either with the slow-speed Type 631-BL STROBOTAC, an external contactor, or for single-flash photography where the very short flash duration of 10 millionths of a second is necessary

When used with the slow-speed STROBOTAC, the STROBOLUME can be flashed up to 1200 per minute for short periods. An external contactor, attached to a shaft, can be used to flash the STROBOLUME at any speed up to 1200 flashes per minute.

A push button and cord are supplied for single flash work. Several types of contactors are available.

TYPE 1532-A STROBOLUME **$225.00**

Type 1530-A MICROFLASH

For ultra-high-speed photography, the MICROFLASH, with its flash duration of only *2 millionths* of a second, is ideal. It can be used to stop such high-speed motion as projectiles in flight and pressure waves in fluids and gases. Its uses in industry are countless where the study of high-speed motion is desired.

The MICROFLASH operates from an a-c line, is portable and can be fired either from the sound wave picked up by the microphone (supplied with the instrument) or by an external contactor.

TYPE 1530-A MICROFLASH **$600.00**

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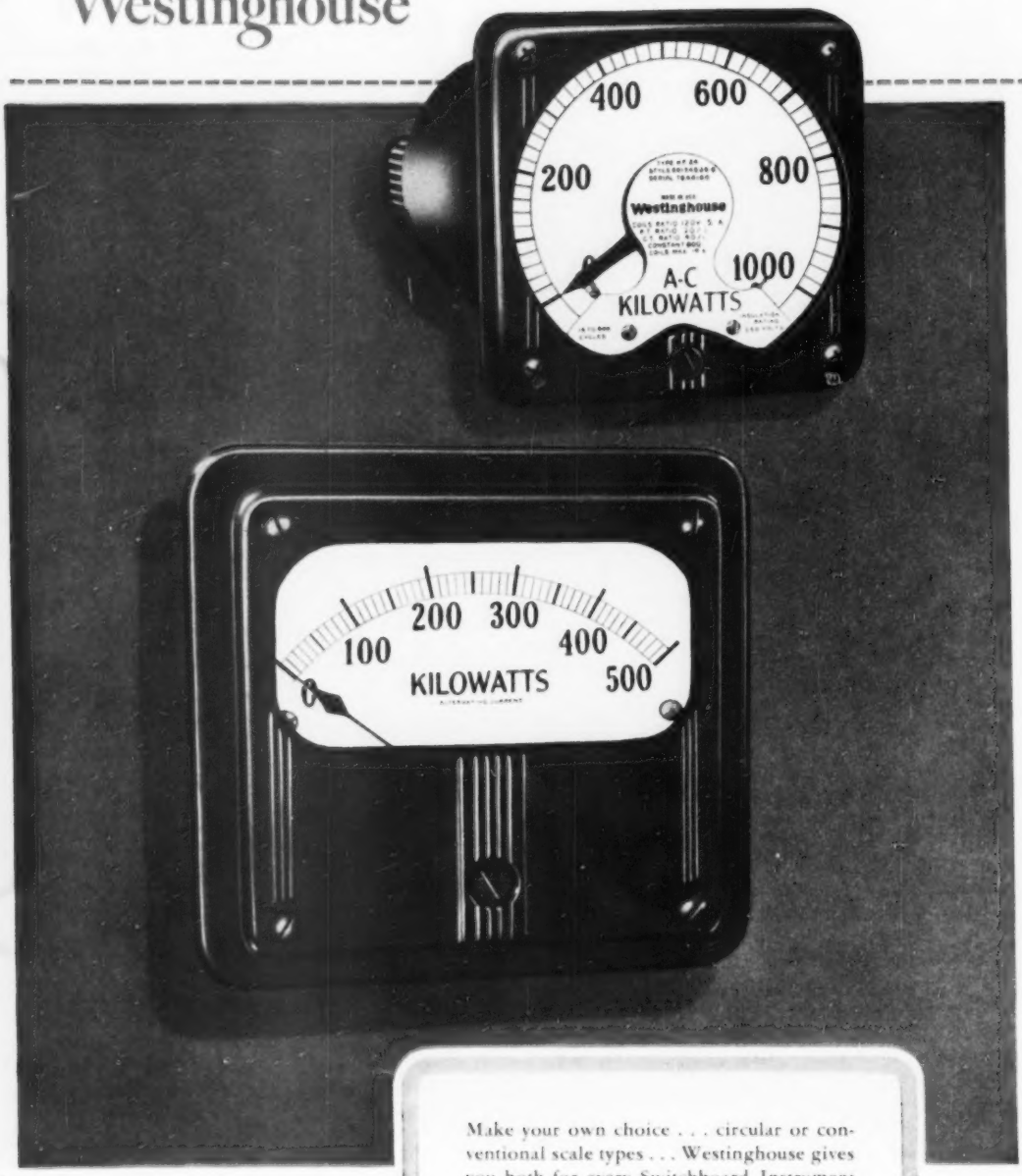

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★ **The most complete line** in the industry . . . for every switchboard and panel requirement . . . available from one source. A-c and d-c current and voltage; single and polyphase; watts and vars; frequency; power factor; synchroscopes; temperature indicators; ground detectors; synchrotie (position indicators).

★ **Meets A. S. A. standards**—Every Westinghouse Switchboard Instrument is built to the rigid specifications of the "American Standards Association".

. . . it takes *all three* to eliminate costly stocks and storage overhead . . . release working capital . . . still meet your own delivery commitments . . . with *assured* high quality!

Westinghouse instrument specialists have nationwide experience in solving instrument application problems of all types . . . are ready to help you answer *your* special problems. Phone, write or wire your nearest Westinghouse representative. For complete information on all switchboard instruments, ask for C. S. 43-200. Westinghouse Electric Corporation, 95 Orange Street, Newark, N. J. J-40391

Specify Westinghouse *- get more for your instrument dollar!*

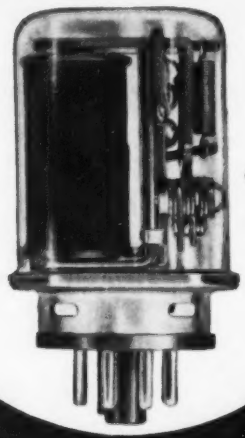
Westinghouse

INSTRUMENTS

NEW SENSITIVE RELAY built for long service

SW RELAY

Hermetically Sealed



Supplied with OCTAL PLUG or SOLDER TERMINALS

Sensitivity Plus Dependability!

The new Allied SW relay offers an economical combination of both these important qualities. Here are the facts on this newest relay in the famous Allied line

Bulletin SW gives complete details. Send for your copy today.

Be sure to send for your copy of Allied's new Relay Guide. It shows 24 small, compact relays with a detailed table of characteristics and specifications.

SENSITIVITY:	S.P.D.T. .012 watts d.c. } Can be supplied D.P.D.T. .05 watts d.c. } in A.C.
COIL:	Acetate insulated, bobbin or layer wound, 12,500 ohms max.
CONTACTS:	Silver, one ampere non-inductive load at 24 volts d.c. or 115 volts a.c. Armature contact at frame potential.
MOUNTING:	One hole with locating lug. Also available with dust cover or hermetically sealed, plug-in or solder terminals.
DIMENSIONS:	Open Relay—1-19/32", 1-1/16", 1-7/16" Sealed Relay—3-3/16" long, including plug, 1-13/32" wide, 1-19/32" high.
WEIGHT:	2.5 oz.
WEIGHT HERMETICALLY SEALED:	4.5 oz.
SPECIAL APPLICATIONS:	Sensitivity down to .003 watts S.P.D.T., or .012 watts D.P.D.T. Palladium or other precious metal contacts for audio or low voltage circuits, tungsten or alloy contacts for higher current or voltage circuits. Maximum input 4.0 watts at 20°C for 85° rise.

ALLIED CONTROL COMPANY, INC.

2 EAST END AVENUE, NEW YORK 21, NEW YORK

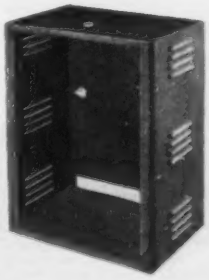
uniformity

Not a foot out of step, not a figure out of line. That's uniformity! Karp Products, too, are always "in line," following the most exacting and precise specifications. That means a saving of time and money on your assembly line. "Uniformity" brings greater efficiency into your production.

Our new 70,000 square foot plant has extensive facilities, including an accumulation of dies and jigs which permits us to fabricate at minimum cost, whether your job is a single unit or a large quantity.

Twenty five years' experience has given our craftsmen a "know how" which is reflected in Karp's quality and accuracy. And you can have this service at competitive prices.

Let us quote on your next requirement of metal cabinets, consoles, chassis, and enclosures. Write today for your FREE copy of our illustrated data book.



KARP METAL PRODUCTS CO., INC.

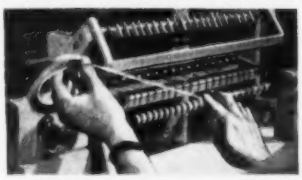
215-63rd Street, Brooklyn 20, New York

MITCHELL-RAND *NOW* HEADQUARTERS *FOR* PERMACEL

cotton cloth • paper • acetate film

ELECTRICAL TAPES

best for all other Electrical Insulations



Now **you can depend upon MITCHELL-RAND to supply your electrical tape requirements for all insulating, tieing and identifying uses . . . and be confident that with MITCHELL-RAND service and PERMACEL TAPES, your electrical equipment and apparatus will have positive insulation and absolute protection.**

PERMACEL ELECTRICAL TAPES **have great dielectric and tensile strength, great tear-resistance, maximum adhesive firmness, excellent varnish penetration, etc. . . . their backings and adhesives minimize abrasion and electrolytic corrosion . . . resist oil, water and acids . . . provide elasticity . . . stick at a touch and hold everlastingly.**

PERMACEL TAPES **have what it takes to insulate, protect, tie and identify . . . and often at lower cost!**

It will pay you to test PERMACEL ELECTRICAL TAPES . . . write today on your letterhead and MITCHELL-RAND will submit samples and descriptive data.

MITCHELL-RAND INSULATION CO., Inc.

ST. MURRAY STREET — CORTLANDT 7-9320 — NEW YORK 7, N.Y.

A PARTIAL LIST OF M-R PRODUCTS: FIBERGLAS VARNISHED TUBING, TAPE AND CLOTH • INSULATING PAPERS AND TWINES • CABLE FILLING AND POTHEAD COMPOUNDS • FRICTION TAPE AND SPLICE • TRANSFORMER COMPOUNDS • FIBERGLAS SATURATED SLEEVING • ASBESTOS SLEEVING AND TAPE • VARNISHED CAMBRIC CLOTH AND TAPE • MICA PLATE, TAPE, PAPER, CLOTH, TUBING • FIBERGLAS BRAIDED SLEEVING • COTTON TAPES, WEBBINGS AND SLEEVINGS • IMPREGNATED VARNISH TUBING • INSULATED VARNISHES OF ALL TYPES • EXTRUDED PLASTIC TUBING

Now available . . . a UHF, tube and socket package to solve your UHF tube and tube-cooling problems.

The combined use of the Eimac 4X150A tetrode and the new Eimac 4X150A socket makes possible improved circuit arrangement especially at frequencies between 100 and 500 Mc. and also simplifies mechanical design of the tube cooling system.

The tube . . . type 4X150A is a highly efficient beam-power Eimac tetrode capable of handling 150 watts of plate dissipation and delivering as high as 140 watts of useful output power per tube in conventional coaxial amplifier circuits. Its high degree of stability, high power-gain, and high ratio of transconductance to capacitance make it ideally suited for service as a video amplifier, TV sound amplifier, FM & TV r-f amplifier, or in UHF communications, and in STL and dielectric heating applications.

The socket . . . type 4X150A/4000, in addition to insuring adequate cooling of the 4X150A, simplifies circuit construction. It incorporates a 3750 $\mu\mu$f screen bypass capacitor and its terminal design reduces lead inductance to a minimum. The 4X150A/4000 socket is engineered for service in either coaxial line or chassis construction.

Take advantage of the tetrode engineering experience of America's foremost manufacturer . . . Eimac. Write today for complete data on the 4X150A, 4X150A/4000 socket and other high performance tubes contained in the new Eimac tube catalogue.

255

Follow the Leaders to Eimac TUBES The Power for R-F

EITEL-McCULLOUGH, INC.
San Bruno, California
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

ELECTRONICS

Designers

NEW! MIDGET, HIGH-TEMPERATURE PULSE-FORMING NETWORKS

Here's a new, extremely compact and lightweight capacitor pulse-forming network that will operate at temperatures up to 120° C! With a volume of 6 cubic inches, it's just about one third the size of a conventional network with the same rating (6E2-.5-2000-50-P2T).

The life expectancy of this 6-kv unit ranges from 3.5 hours at 80° C ambient to 1 hour at 110°. A second new network twice this size has a life of about 330 hours at 100° C—9 hours at 120° C. If you want more data on these new units, write *Capacitor Sales Division, General Electric Company, Pittsfield, Mass.*

DELAY LINES—BY THE FOOT

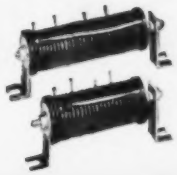
These G-E delay lines provide a means for delaying signals with a band-width up to 2-megacycles for any time interval from .25 to 10.00 microseconds. They are available in bulk form in lengths up to 100 feet—delay equals approximately ½ microsecond per foot. Characteristic impedances of 1100 and 400 ohms per foot are available. Since the line is very flexible, it may be bent into 4-inch diameter coils.

Ordering line in bulk form makes it possible for you to cut it to the exact length required for your particular application. For complete ratings and specifications, see Bulletin GEC-459.

GENERAL ELECTRIC

Digest

TIMELY HIGHLIGHTS ON G-E COMPONENTS



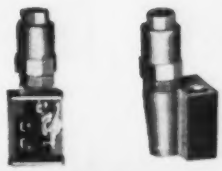
MORE COMPACT RECTIFIER STACKS

If your requirements call for compact selenium stacks for operation in cramped quarters, these new, higher-voltage G-E selenium cells may be your answer. Their 18-volt d-c output means you can design stacks which are about 25% smaller than possible with 12-volt cells. The improved aging characteristics of these cells is made possible by a new G-E evaporation process which deposits selenium on aluminum with greater uniformity. Stacks are available with rated outputs of 18 to 126 d-c volts at 0.15 to 1.20 amperes with inputs of 23 to 180 a-c volts. See Bulletin GEA-5280.

TIME METERS—TO CHECK TUBE LIFE

G-E time meters, with dependable Telechron* motor drive, are especially useful in recording the operating time of radio transmitters or other electronic devices so that tubes may be replaced before they fail. They record operating time in hours, tenths of hours, or minutes, and are supplied for 11-, 115-, 230-, or 460-volt operation. The case is of molded textolite to harmonize with other G-E 3½-inch instruments mounted on the same panel. You'll find more description along with dimensions and pricing information in Bulletin GEC-472.

*Reg. U.S. Pat. Off.



NEW! WATER-FLOW INTERLOCK

This new G-E flow interlock provides sure protection against overheating in water-cooled components such as tubes, transformers, and dynamotors. Its function is to open the electrical circuit when water flow is lower than a preset minimum and close it when flow is above this point.

Adjustment can be made to actuate the electrical contact for any flow between 1 gallon per minute and 4 gallons per minute. The cut-in, cut-out differential of the unit is 0.2 gpm. The electrical circuit is rated at 10 amperes at 125 volts a-c, 5 amperes at 250 volts a-c and 3 amperes at 460 volts a-c. Maximum water-line pressure rating is 125 pounds per square inch. The unit is bronze with standard ½-inch fittings and is easy to install and adjust. For further description see Bulletin GEC-411.

NEW! BATTERY-OPERATED VTVM

This new G-E battery-operated electronic voltmeter combines the portability of an ordinary low-sensitivity multimeter with the high sensitivity and versatility of a line-voltage-operated vacuum-tube voltmeter.

Its weight is only 4 pounds (with batteries), its size—3"x6"x8", but it measures *a-c and d-c voltage* in 7 ranges from 0-1 to 0-1000 volts, *d-c current* in 4 ranges from 0-1 to 0-1000 milliamperes, *resistance* in 5 ranges from 100 ohms to 10 megohms, mid-scale value.

D-c input impedance is 11 megohms on all ranges. A-c input impedance is 0.5 megohm shunted with 20 mmf on all ranges. Frequency response is flat within 5 per cent up to 15,000 cycles on all up to and including the 0-100-volt range. More data in Bulletin GEC-622.

General Electric Company, Section D667-5
Apparatus Department
Schenectady 5, N. Y.

Please send me the following bulletins:

(Indicate: ☑ for reference only; ☒ for planning an immediate project)

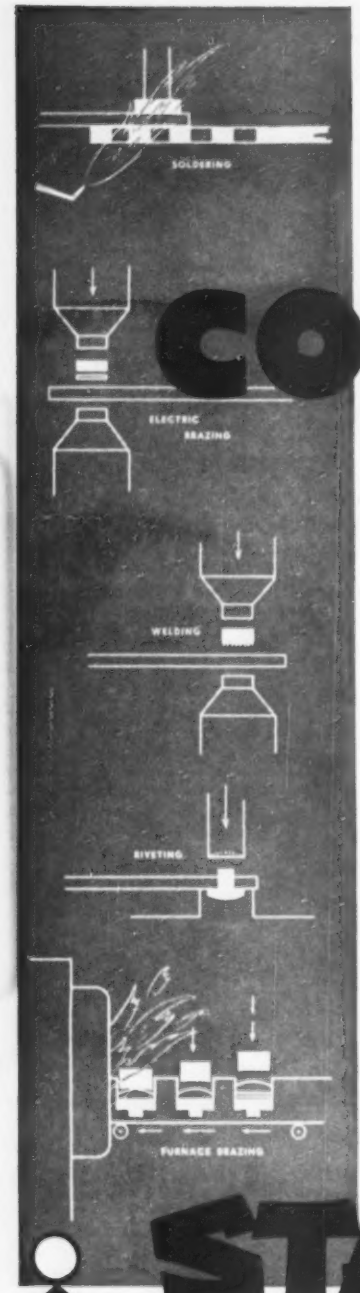
- ☐ **GEA-5280 Selenium rectifiers**
- ☐ **GEC-411 Flow interlock**
- ☐ **GEC-459 Delay lines**
- ☐ **GEC-472 Time meters**
- ☐ **GEC-622 Electronic voltmeter**

NAME .....

COMPANY .....

ADDRESS .....

CITY ..... **STATE** .....



A money-saving tip on

CONTACTS

LEADING users of Stackpole contacts for original equipment have saved money, assured greater product dependability, not only by having us recommend the most suitable method for attaching contacts to their arms, but also by letting us handle this specialized attachment job.

Based on long experience, Stackpole engineers are fully familiar with the advantages and disadvantages of the various attachment methods for different contact materials and applications. The best, most economical method can quickly be selected—and the entire operation handled on modern equipment and in such a manner that contact performance or durability will in no wise be impaired. Scrap contacts are eliminated—you pay only for those supplied in complete, properly attached form.

WRITE FOR CATALOG 12 describing Stackpole contact types and containing a wealth of helpful contact data including choice of contact materials and contact attachment information.

STACKPOLE CARBON COMPANY, St. Marys, Pa.

STACKPOLE

CONTACTS

All shapes and sizes in SILVER GRAPHITE • SILVER LEAD OXIDE • SILVER NICKEL SILVER MOLYBDENUM • SILVER TUNGSTEN • COPPER GRAPHITE • PRECIOUS METAL

. . . and many special materials

the new DUMONT type 12LP4A TELETRON*

Bent-Gun, exclusive DuMont design, bends the electron beam only once instead of twice as in other designs. Permits sharper spot focus.

New Du Mont gray face plate

Featuring the

BENT-GUN

For the first time this popular tube type is offered with all the refinements of the Du Mont design.

Modification of the Bent-Gun makes possible the use of single or double magnet beam-benders thus assuring direct interchangeability with other 12LP4's, yet assuring that extra sharpness possible only with the Du Mont gun structure.

An ideal tube for improving the performance of existing receivers, using the Type 12LP4, or for incorporation in new receiver design.

Literature and quotations on request

Specifications

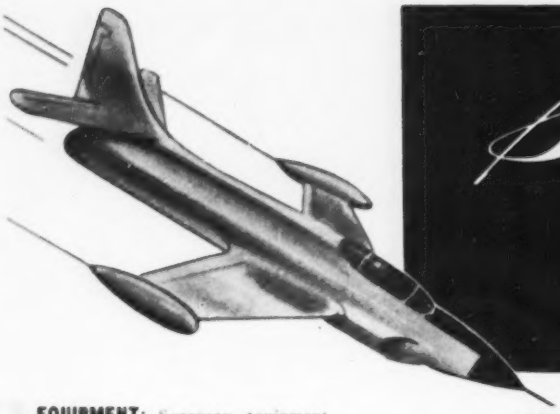
Overall Length	18¾"
Diameter of Bulb	12-7/16"
Useful Screen Diameter	11"
Base	Duodecal 5 Pin
Bulb Contact	Recessed Small Cavity Cap
Anode Voltage	11,000 Volts D. C.
Grid No. 2 Voltage	250 Volts D. C.
Focusing Coil Current	110 Approx. Ma D. C.
Ion Trap Current	120 Approx. Ma D. C.
Grid No. 1 Circuit Resistance	1.5 Max. Megohms

DUMONT Teletrons

FIRST WITH THE FINEST IN T-V TUBES

*Trade-Mark

ALLEN B. DU MONT LABORATORIES, INC., Tube Division, Clifton, N. J. Plants at Allwood and Passaic, N. J.



Sorensen

ELECTRONIC EQUIPMENT FOR *AVIATION*

EQUIPMENT: Sorensen equipment (400 cycle line voltage regulators, Inverters, Regulated DC supplys, Frequency changers and Phase Adapters) are lightweight, designed for conformity to JAN specifications.

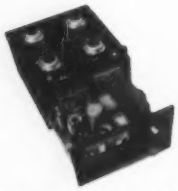
TEST EQUIPMENT AIDS: Sorensen's voltage regulating equipment (400 cycle Line Regulators, DC supplys or "Nobatrons") can facilitate the use of test equipment by providing regulated AC or DC power.

SORENSEN: offers the Aviation field three principal types of product:

COMPONENTS: Sorensen has a wide range of products which can be used to great advantage in aviation manufacturers' equipment. Chief among these are the 400 cycle variable auto transformers, the Saturable Core reactors and other power components. Equipment units can be designed to meet JAN specifications.

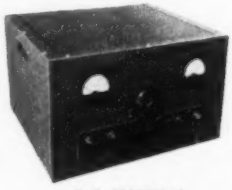
FOSTERITE: In airborne units, Sorensen seals its wound components against humidity by the Fosterite process, a method which adds little to weight or size, and is, therefore, ideal in aircraft electronic design.

TYPICAL SORENSEN AIRBORNE UNITS



400 CYCLE REGULATOR
± 0.5% regulation; 400 cycles ± 10%; 5% distortion; 50 VA to 3 KVA capacities.

ELECTRONIC INVERTER
Inverters and Frequency changes under development. Specifications on request.



DC SUPPLY
0-325 VDC; 0-500 VDC; 300-1000 DC regulated ± 0.5%; 125, 300, 500 ma.

NOBATRON
6-12-28-48-125 VDC from 5-350 amperes; regulated ± 0.25%; 60 or 400 cycles input.

400 CYCLE AUTO TRANSFORMER
0-130 VA; 400 Cycles 5 and 15 amperes.

SATURABLE CORE REACTOR
For magnetic amplifier circuits. Request data book.

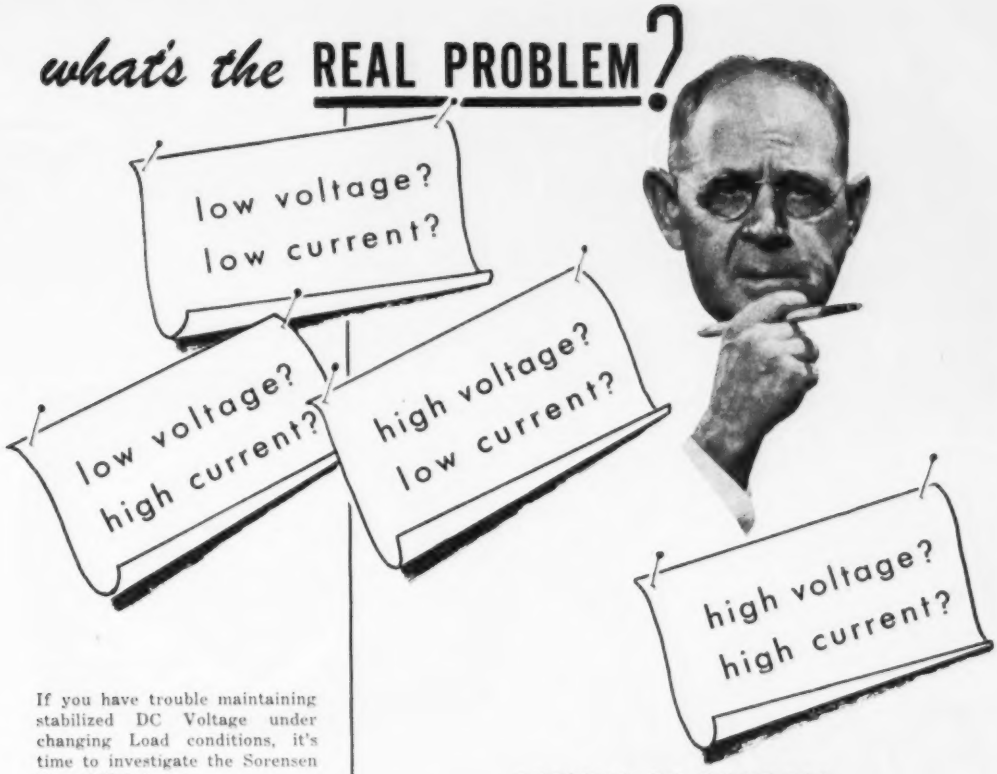
LITERATURE: The following literature is available on request: Catalog A 1049 (AC regulators); Catalog B 1049 (Nobatrons and DC supplys); Catalog C 1049 (wound components and fosterite); Saturable Core Reactor Technical Data sheets; "Aircraft" issue of "Currently."

controlled POWER converted

Sorensen and company, inc.
375 FAIRFIELD AVE. • STAMFORD, CONN.

MANUFACTURERS OF AC LINE REGULATORS, 60 AND 400 CYCLES; REGULATED DC POWER SOURCES; ELECTRONIC INVERTORS; VOLTAGE REFERENCE STANDARD; CUSTOM BUILT TRANSFORMERS; SATURABLE CORE REACTORS

what's the REAL PROBLEM?



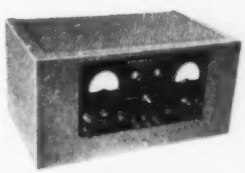
If you have trouble maintaining stabilized DC Voltage under changing Load conditions, it's time to investigate the Sorensen line of Nobatrons.

- **Common Nobatron Specifications:** Regulation Accuracy 0.2% from 0.1 load to full load; Ripple Voltage 1%; Recovery time 0.2 seconds under most severe change in load or input conditions; 95-130 VAC single phase 50-60 cycles: adapter available for 230 VAC operation.

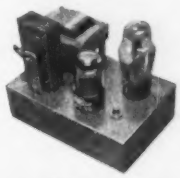
- **Ratings**
  Nobatron — 6, 12, 28, 48, 125 volts from 5-350 amperes.
  B-Nobatron — 325, 500, 1000 volts — 125 ma.; 300 ma. & 500 ma.
  DC Standards — 2, 6, 15, 25, 50, 75, 150, 300 volts — 15, 30 and 50 ma.

- **Problems?** Sorensen Engineers are always at your service to help solve unusual applications.

TYPICAL DC SOURCES

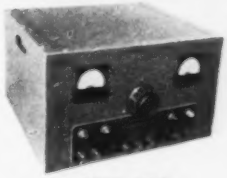


MODEL 325B
0-325 volts; 125 ma.



MODEL VS-50-50
50 volts @ 50 ma.

MODEL E-6-15
6 volts; 1.5-15 amperes



MODEL 500B
0-500 volts; 300 ma.

WRITE TODAY For Catalog B1049 For The Complete Line And Prices.

controlled converted **POWER**

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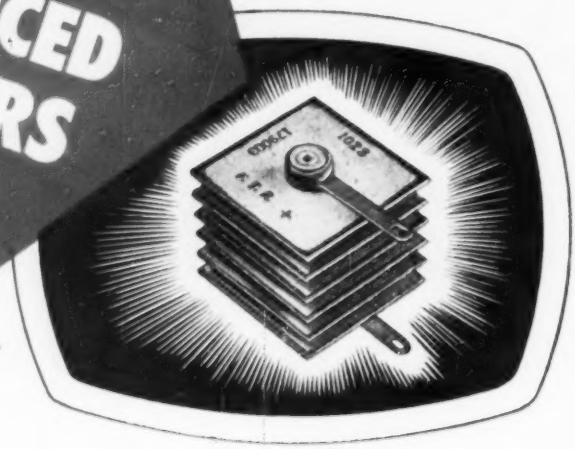
MANUFACTURERS OF AC LINE REGULATORS, 60 AND 400 CYCLES; REGULATED DC POWER SOURCES; ELECTRONIC INVERTORS; VOLTAGE REFERENCE STANDARD; CUSTOM BUILT TRANSFORMERS; SATURABLE CORE REACTORS

The "POWER" behind the Big Trend to LOWER-PRICED TV RECEIVERS



Federal's

Miniature SELENIUM RECTIFIER

The new trend in television is to receivers of higher-than-ever quality . . . at lower-than-ever prices!

The "power" behind this fast-growing swing is Federal's Miniature Selenium Rectifier . . . a vital factor in bringing *better* television to *more* people.

Sales-wise manufacturers are utilizing this revolutionary component to drastically reduce the size, weight and cost of TV receivers . . . by eliminating heavy, bulky, expensive power transformers . . . expendable rectifier tubes . . . filter chokes.

Specifically designed for television service, Federal Miniature Selenium Rectifiers are readily available in ratings to cover the full range of TV power requirements of sets using from 7" to 20" picture tubes.

Write today for full information. Address Dept. F-913.

Made by America's Oldest and Largest Producer of Selenium Rectifiers.

Federal Telephone and Radio Corporation

SELENIUM and INTELIN DIVISION, 100 KINGSLAND ROAD, CLIFTON, NEW JERSEY
In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N. Y.

Why JAN?

For many years the manufacture of transformers was controlled by individual manufacturer's ingenuity and ability together with his customer's desires and requirements. Inevitably there were as many different constructions and variations for any one type of transformer as there were manufacturers and customers. Each design duplicated the function of another and yet, no two were physically interchangeable.

This became most obvious at the beginning of the last war for each branch of the government services had its own specification for components-transformers as well as all other electronic components.

Development of new equipment, production on existing designs, and replacement of parts for existing equipment all presented their own problems when it came to duplication and interchange of supplies. Standardization was *imperative!*

How JAN?

Therefore, the Standards Agency was established by the Armed Forces to correlate manufacturing procedures and devise one best design for a particular job—satisfactory to all military arms, readily available and always interchangeable.

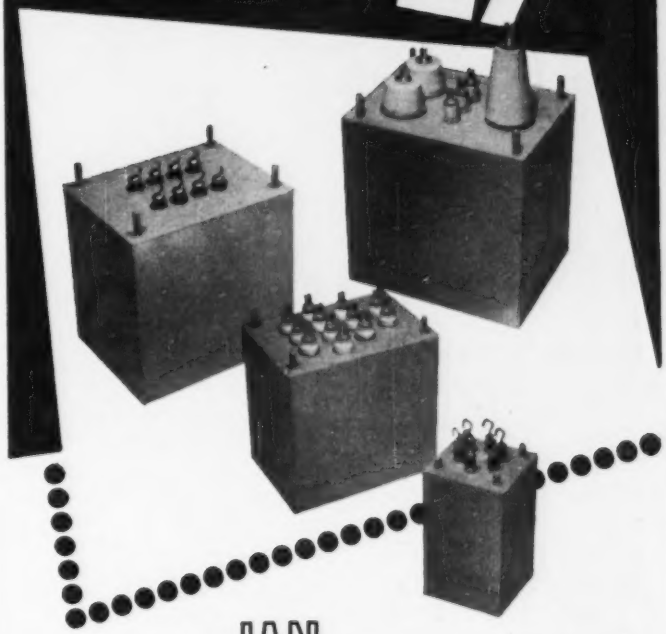
Transformers created a much greater problem than other components due to the many styles and variations in existence, nevertheless standard specifications for the various components, including transformers, were devised by the Standards Agency thru study, development and constant testing.

Thru extensive research in new products and methods, we, at Kenyon, are able to produce high quality transformers, in accordance with the JAN Specification for transformers, namely JAN-T-27.

If you have any questions on JAN Transformers, do not hesitate to call upon Kenyon's engineering staff.

(ADVERTISEMENT)

JAN T-27



What does JAN mean to you today?

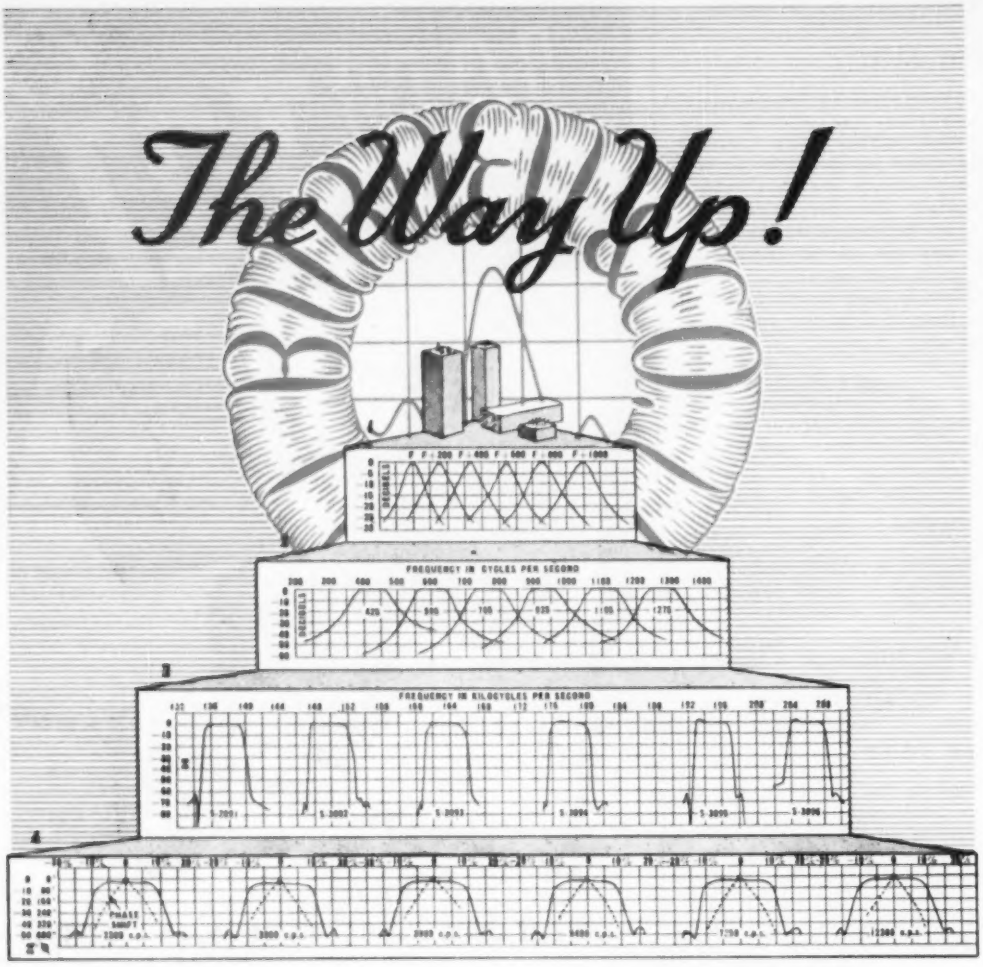
Now — KENYON gives you the complete story on JAN. Since the inception of Joint Army and Navy specifications, KENYON has built JAN-type transformers for leading manufacturers throughout the country.

For more than 20 years, the KENYON "K" has been a sign of skillful engineering, progressive design and sound construction.

Consult our engineering staff today on your JAN problems — at no obligation to you. Call or write *now* for a representative.

Kenyon
TRANSFORMER CO., Inc.
840 BARRY STREET • NEW YORK 59, N. Y.

The Way Up!



1 SUB-MINIATURE "GUIDED MISSILES" FILTERS

For security reasons details of this development in miniaturization must be omitted. It can be told, however, that all six channels are contained in a total volume of 18 cubic inches or 3 cubic inches per channel.

2 TONE CHANNEL FILTERS

Available for either 170 or 340 cycles spacing between channels. These filters have received wide acceptance and are extremely popular among manufacturers of carrier telegraph equipment. In addition to the many standard types of tone filters we are supplying, special characteristics can readily be incorporated into designs to suit your application.

3 CRYSTAL ELEMENT CHANNEL FILTERS

These extremely sharp wide band filters employing crystals and toroidal coils, were so compact that they were substituted in Air Force equipment for ordinary I.F. transformers. Result was tremendous improvement in selectivity and signal to noise ratio. We derived great satisfaction from this achievement.

4 TELEMETERING FILTERS

Among the earliest to be employed in the improved telemetering system now in general use. Particular attention has been paid to linearity of phase shift and good transient suppression as well as high interchannel attenuation in order to eliminate distortion in telemetering reception.

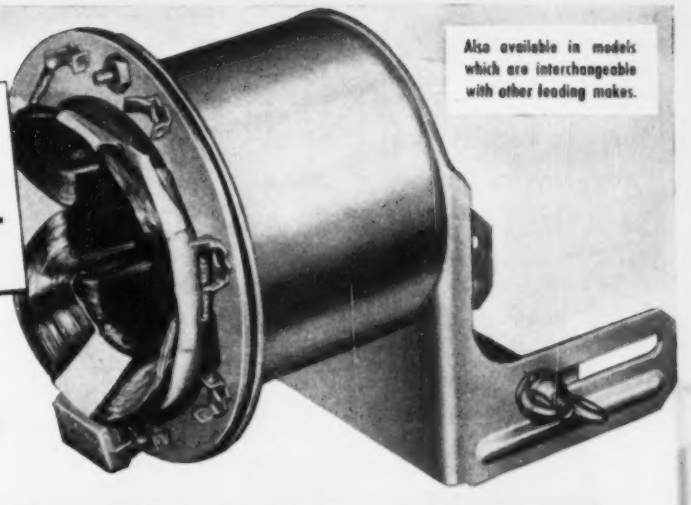
WRITE FOR TECHNICAL INFORMATION

Burnell & Company
YONKERS 2, NEW YORK

ALL INQUIRIES WILL BE PROMPTLY HANDLED

Exclusive Manufacturers of Communications Network Components

TV RECEIVER MANUFACTURERS—



Also available in models which are interchangeable with other leading makes.

New

DEFLECTION YOKE SWEEPS 70° WITH HIGH EFFICIENCY!

Requires only 20 watts of horizontal input power from 260-volt supply!

A 70° tube is tough to sweep—and to do it correctly takes a lot of power, particularly at 13-14kv. Most yokes today lose efficiency when required to sweep wide-angle tubes.

Now an improved General Electric Deflection Yoke, ready for delivery to manufacturers, licks the problem from the inside out. G-E engineers at Electronics Park found that the key to more sensitivity and greater efficiency was in the design and position of the yoke windings. To get a wire pattern that would assure a high degree of uniformity of the magnetic field, they designed an improved machine that winds coils with knife-sharp precision and without distortion. This process now helps turn out yokes that provide accurately-shaped, straight-sided pictures.

For applications requiring high efficiency, the new yoke is available with ferrite core. The complete G-E line of television components also includes ion traps, focus coils, horizontal sweep transformers, size and linearity controls. General Electric engineers will be glad to consult with you on the applications of these components to your designs. Wire or write: *General Electric Company, Parts Section, Electronics Park, Syracuse, New York.*

You can put your confidence in—

GENERAL ELECTRIC

PRECISION FREQUENCIES

ACCURACY: 1 PART IN 100,000 (OR BETTER) .001%

FOR USE IN SUCH FIELDS AS

AVIATION
ASTRONOMY
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HIGH-SPEED PHOTOGRAPHY
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NUCLEAR PHYSICS
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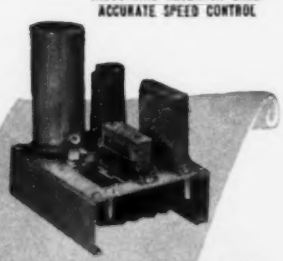
CHEMICAL REACTION
NAVIGATION
SCHOOL LABORATORIES
INDUSTRIAL RESEARCH LABS.
ACCURATE SPEED CONTROL

The controlling unit of these frequency standards is a bi-metallic fork, temperature-compensated and hermetically sealed against humidity and variations in barometric pressure. When combined with related equipment, accurate speed and time controls are afforded by mechanical, electrical, acoustical or optical means.

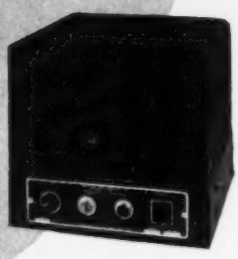
Instruments of our manufacture are used extensively by industry and government departments on such precision work as bomb sights and fire control.

Whatever your frequency problems may be, our engineers are ready to cooperate.

When requesting further details, please specify the Type Numbers on which information is desired.



TYPE 2001-2. BASIC UNIT
Frequencies, 200 to 1500 cycles. Dividers and Multipliers available for lower and higher frequencies. Miniaturized and JAN construction. Output, 6 volts.



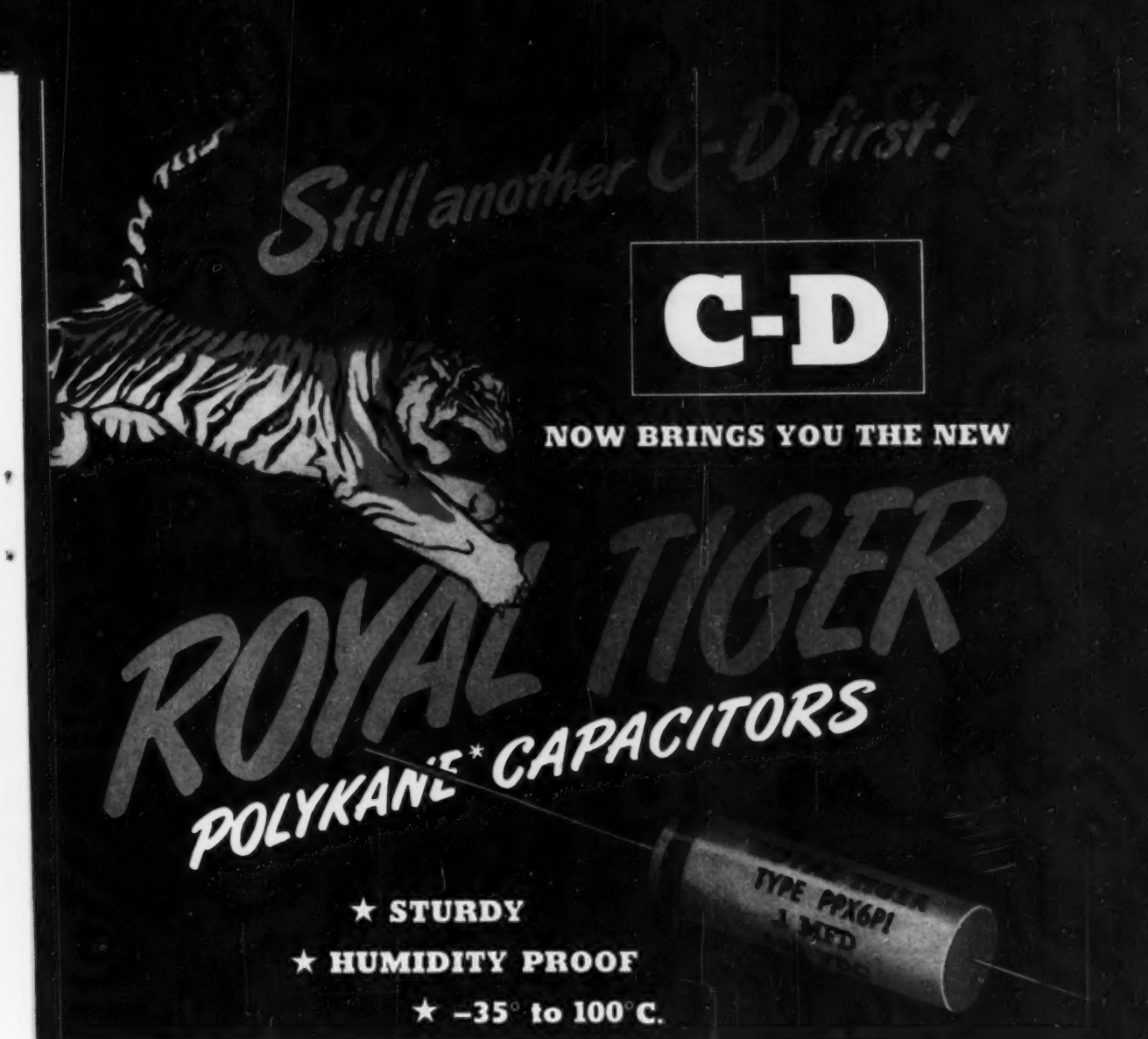
TYPE 2005. UTILITY UNIT
consists of Type 2001-2 and booster to provide 10 watts at 110 V at 60 cyc. Input, 50-100 cyc.

TYPE 2121A. LAB. STANDARD
Outputs, 60 cycle, 0-110 Volts. 120-240 cycle impulses.
Input, 50-400 cycles, 45 W.

TYPE 2111. POWER UNIT
50 W output. 0-110 V at 60 cyc.
Input, 50-100 cyc., 275 W.

American Time Products, Inc.
550 Fifth Avenue *New York 19, N. Y.*

OPERATING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY



***Polykane** – a solid synthetic thermosetting compound, developed by C-D engineers for use in Royal Tigers – provides new sturdy construction for operation at temperatures from –35°C to +100°C.

Royal Tiger Capacitors are Polykane impregnated and filled, resulting in exceptionally uniform electrical properties and performance over extra long service life. No oil or wax used within capacitor. End seal or impregnant will not flow at any temperature.

Royal Tiger Capacitors now make possible a standardized line of tubulars for operation at temperatures up to 100°C., thus eliminating need for stocking low and high temperature oil or wax tubular capacitors.

For full details, write for Bulletin RT349. CORNELL-DUBILIER ELECTRIC CORPORATION, Dept. K-50, South Plainfield, New Jersey. Other plants in New Bedford, Brookline and Worcester, Mass.; Providence, R. I.; Indianapolis, Ind., and subsidiary, The Radiart Corp., Cleveland, Ohio.

40TH ANNIVERSARY CORNELL-DUBILIER CAPACITORS 1910-1950

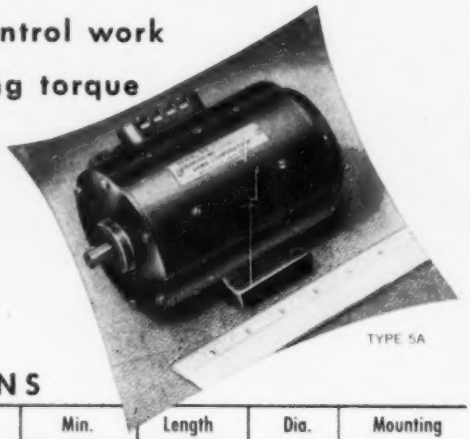
CORNELL-DUBILIER
CAPACITORS

Announcing 2

ARMA STEP MOTORS

. . . designed to replace a Synchro Unit and a servo motor in remote control work requiring torque

TYPE 3A



TYPE 5A

TYPICAL SPECIFICATIONS

	Dwg. No.	Voltage	Weight (Approx.)	Min. Stall Torque	Length Overall	Dia.	Mounting
Type 3A	715774-1	115 V d.c.	3 lb.	22 oz. in.	3-15/32"	3 in.	Flange
Type 5A	51224-1	115 V d.c.	10 lb.	55 oz. in.	6-11/16"	3⅝ in	Bracket type Base

FEATURES

• *Convenient mounting* • *Accurately ground, true running shaft extensions* • *Self-contained terminal blocks* • *Low power consumption* • *Conservative electrical design, low temperature rise, large creepage distances and air gaps*

COMPARED WITH ALTERNATING CURRENT SYNCHRO UNIT

- Much greater torque available than from same size A.C. Synchros.
- Both are used primarily for the transmission of data from one point to another. Both serve as remote indicators or repeaters.

Step Motor Booklet Just Printed Gives Complete Details
ASK FOR A COPY

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ARMA PRODUCTS RELEASED FOR PRIVATE INDUSTRY

ARMA ELECTRICAL RESOLVERS* ARMA SYNCHROS ARMA INDUCTION MOTORS ARMA INDUCTION GENERATORS ARMA MECHANICAL DIFFERENTIALS ARMA ALTERNATING VOLTAGE COMPARATOR COMPUTING MECHANISMS INDUSTRIAL CONTROLS STABILIZATION DEVICES NAVIGATIONAL EQUIPMENT LIMITRON AUTOMATIC INSPECTION SYSTEM

* Licensed for use under Arma patents Nos. 2,465,624 and 2,467,660. License information available.

QUALITY ARMA INSTRUMENT PRECISION

*TRADE MARK

Combines all the Desirable Properties of Formvar and Nylon Coatings

Years of development work have produced this new and superior magnet wire insulation. Belden Nylclad* Magnet Wire combines the desirable properties of Formvar and Nylon types. Its tough, durable coating eliminates the need for paper or textile-covered wires (in many applications) and reduces winding space requirements. Nylclad* provides increased toughness, increased solvent resistance, and resistance to softening under heat; it is not subject to solvent crazing. Nylclad* means improved windability — more compact coils — many over-all plus values at *no* increase in price.

It will pay you to investigate Nylclad* Magnet Wire — another Belden development that makes for lower over-all costs. Write, today, for test data.

Belden

MAGNET WIRE

Belden Manufacturing Co., 4625 West Van Buren Street, Chicago, Illinois

PRECISION ATTENUATION to 3000 mc!

*Patents applied for

- VSWR less than 1.2 at all frequencies to 3000 mc.
- **Turret Attenuator*** featuring **"Pull — Turn — Push"** action with 0, 10, 20, 30, 40, 50 DB steps.
- Accuracy ± .5 DB, no correction charts necessary.
- 50 ohm coaxial circuit. Type N connectors.

Inquiries are invited concerning single pads and turrets having other characteristics

STODDART AIRCRAFT RADIO CO.
6644 SANTA MONICA BLVD., HOLLYWOOD 38, CALIFORNIA
Hillside 9294

Specify G-E THYRATRONS!

More General Electric thyratron tubes are built and sold than any other make. Here is *leadership* . . . a signpost for the designer of motor-control circuits, pointing to where experience and proved tube quality are waiting!

Choice of types, too, is virtually unrestricted. In the wide range of G-E thyratrons will be found the right tube —small or large, ideal in its design characteristics—for *your* equipment.

Three popular G-E thyratrons are shown here. Each has its special area of application. The GL-3C23 is a gas-and-mercury-vapor tube for motor field control, where inductive loads are heavy. The GL-5544 and GL-5545 are gas-filled tubes especially suited to armature-control work, which involves a higher current—these thyratrons having a charge of inert gas twice that of less modern types, to offset any absorption.

Long, cost-saving life, from features like the higher gas charge of the GL-5544 and GL-5545, gives *extra tube value.* Let General Electric tube engineers work with you in choosing thyratrons that will accent your equipment's economy, help assure its reliability, extend its performance span! Phone your nearby G-E electronics office, or wire or write *Electronics Department, General Electric Company, Schenectady 5, New York.*

Available now...new G-E tube socket (101J328) that resists the heat produced in heavy-duty service. Made of asbestos-filled phenolic material, with special high-temperature-alloy spring contacts that won't lose their elasticity, and an open design allowing generous air circulation. Universal type: takes both the medium 4-pin base used in the GL-3C23, and the super-jumbo base used in the GL-5544 and GL-5545. Mounts either above or beneath a panel.

	GL-3C23	GL-5544	GL-5545
Filament voltage	2.5 v	2.5 v	2.5 v
Filament current	7 amp	12 amp	21 amp
Peak anode voltage, forward and inverse	1,250 v	1,500 v	1,500 v
Peak cathode current	6 amp	40 amp	80 amp
Avg cathode current	1.5 amp	3.2 amp	6.4 amp

GENERAL ELECTRIC

180-J87

MORE *Andrew* FIXED STATION ANTENNA EQUIPMENT IS USED THAN ANY OTHER KIND!

HERE'S WHY: The topnotch engineering that only the world's largest antenna equipment specialists can give . . . the uniform dependability of Andrew equipment . . . its superior performance . . . the fact that only Andrew makes a complete line of fixed station antenna equipment.

But that's not all. An imposing parade of "firsts" maintain Andrew leadership. Some current Andrew "firsts" are 1) the exclusive Folded Unipole Antenna, 2) the new Hurricane Models, 3) the Corner Reflector Antenna, and 4) a Very High Gain Communications Antenna soon to be announced.

COAXIAL CABLE, Type 737. Significantly, there is more of this Andrew ⅞" diameter cable now in use than all similar makes combined! You get a bonus of extra miles added to your service radius because loss characteristics are exceptionally low.

FOLDED UNIPOLE ANTENNAS. Another Andrew "first" and made only by Andrew. Thousands of these popular antennas are in use at fixed stations throughout the world. More new stations are using it than any other antenna. Users acclaim 1) its quieter reception produced by the grounded radiating element, 2) the excellent impedance match, and 3) its greater transmitting coverage.

Extra! Now available in Hurricane Models to insure uninterrupted operation when you need it the most.

COAXIAL ANTENNAS. Most economical where signal-to-noise ratio is high. Above 108 MCS only.

CARDIOID ANTENNAS. If you operate along a shore or border line and want your signal to cover only a certain 180° area, this rugged antenna is made to order for you. It concentrates your signal where you want it and doesn't waste radiation where you don't want it.

CORNER REFLECTOR ANTENNAS. For narrow angle coverage or point-to-point relaying. Concentrates your signal in the exact area where you want it, using a 60° beam. Avoids interference to and from the remaining area. For the 72-76 and 148-174 MCS bands. Only Andrew makes a commercial model of this special purpose antenna—another Andrew "first."

It will pay you, too, to use Andrew fixed station equipment. Write for further information—today!

VERY HIGH GAIN COMMUNICATIONS ANTENNA
(soon to be announced)

The highest gain antenna in mobile communications history. It actually delivers the full gain of 6.5 db as claimed—the same as increasing your power 4½ times! Think of the economy. Now, for the first time, you can cover areas you couldn't reach before! It's another pace-setting Andrew "first." Frequency range is 148-174 MCS.

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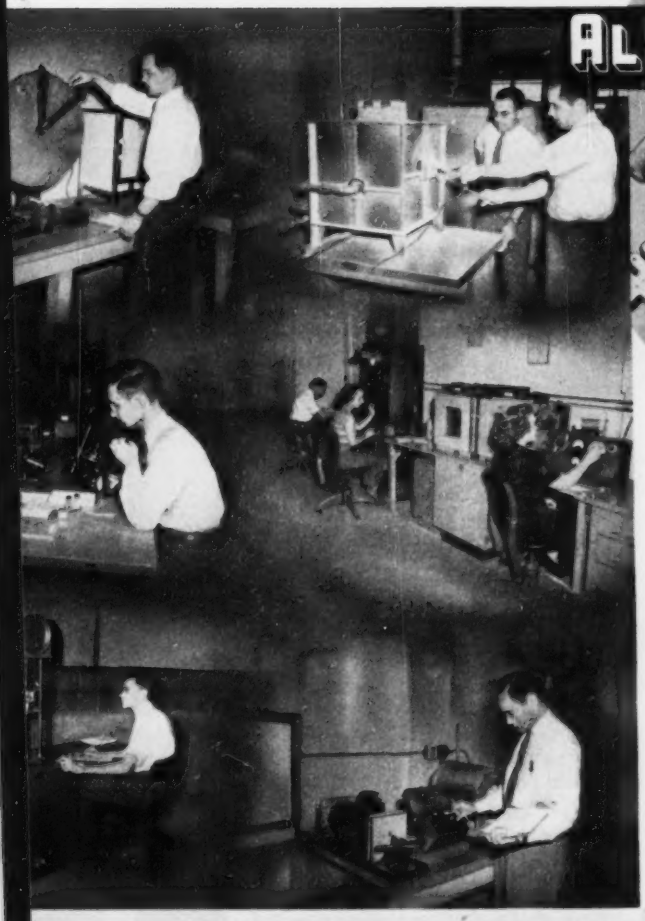
research

at American Lava Corporation is continuous, to anticipate and answer your problems on Custom Made Technical Ceramics



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REVERE FREE-CUTTING COPPER ROD
. . . INCREASES ELECTRONIC PRODUCTION

SINCE its introduction, Revere Free-Cutting Copper has decisively proved its great value for the precision manufacture of copper parts. Uses include certain tube elements requiring both great dimensional precision, and exceptional finish. It is also being used for switch gear, high-capacity plug connectors and in similar applications requiring copper to be machined with great accuracy and smoothness. This copper may also be cold-upset to a considerable deformation, and may be hot forged.

Revere Free-Cutting Copper is oxygen-free, high conductivity, and contains a small amount of tellurium, which, plus special processing in the Revere mills, greatly increases machining speeds, makes possible closer tolerances and much smoother finish. Thus production is increased, costs are cut, rejects lessened. The material's one important limitation is that it does not make a vacuum-tight seal with glass. In all other electronic applications this special-quality material offers great advantages. Write Revere for details.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: 230 Park Avenue
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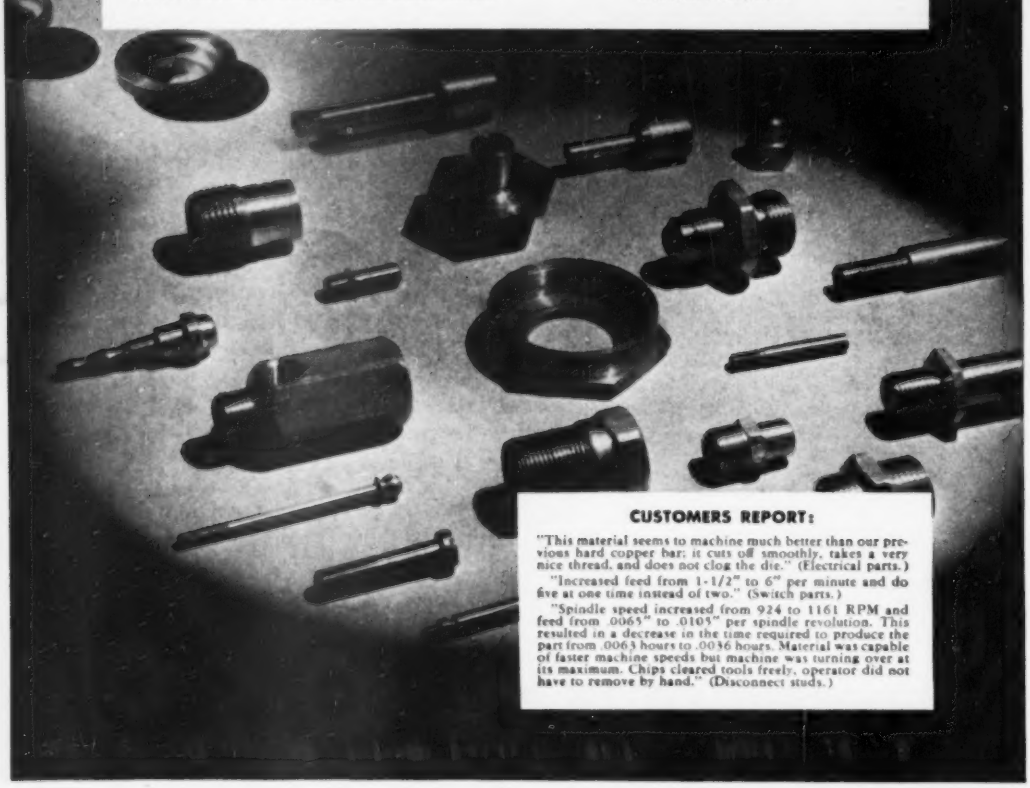
Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y. — Sales Offices in Principal Cities, Distributors Everywhere.



CUSTOMERS REPORT:

"This material seems to machine much better than our previous hard copper bar; it cuts off smoothly, takes a very nice thread, and does not clog the die." (Electrical parts.)

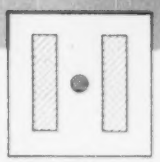
"Increased feed from 1-1/2" to 6" per minute and do five at one time instead of two." (Switch parts.)

"Spindle speed increased from 924 to 1161 RPM and feed from .0065" to .0105" per spindle revolution. This resulted in a decrease in the time required to produce the part from .0063 hours to .0036 hours. Material was capable of faster machine speeds but machine was turning over at its maximum. Chips cleared tools freely, operator did not have to remove by hand." (Disconnect studs.)

hp 805A SLOTTED LINE

PRECISION ACCURACY FOR STANDING WAVE MEASUREMENTS

$475 f.o.b. Palo Alto



RADICAL NEW "PARALLEL-PLANE" DESIGN GIVES -*hp*- SLOTTED LINE UTMOST ELECTRICAL STABILITY

The new -*hp*- 805A Slotted Line employs two parallel planes and a large, circular central conductor, instead of the conventional coaxial configuration. This new design makes possible an electrically stable precision instrument capable of fast, easy measurements of unvarying accuracy. Parallel planes and central conductor are both mechanically rigid. Penetration depth of the probe is less critical than in coaxial slotted lines, and leakage is low because the effective slot opening is less than .001 referred to the coaxial system. Residual VSWR is held to less than 1.04. Probe position may be read to 0.1 mm.

This new approach to the Slotted Line problem makes possible the manufacture of an instrument of maximum accuracy at moderate cost.

SPECIFICATIONS

Frequency Range: 500 to 4,000 mc.

Impedance: 50 ohms.

Connections: Special Type "N" fittings designed for minimum VSWR.

Residual VSWR: 1.04 or better.

Slope: Negligible.

Calibration: Metric, in cm and mm. Vernier reads to 0.1 mm.

Size: 27" long, 8" high, 6" wide.

Carriage: Ball-bearing probe movement. Probe depth adjustable. Probe resonant circuit tunable over freq. range of line. Detector may be standard crystal or employ barretters.

Data subject to change without notice.

WRITE FOR DETAILS

HEWLETT-PACKARD COMPANY

1824-A Page Mill Road · Palo Alto, California

1824

NEW -*hp*- 415A

Standing Wave Indicator

The new -*hp*- 415A Standing Wave Indicator is used with the -*hp*- Slotted Line to determine coaxial flatness or measure impedance. It consists of a high gain amplifier of low noise level, operating at a fixed audio frequency. Amplifier output is measured by a voltmeter with a square-law calibration in db and voltage standing wave ratio. The -*hp*- 415A is direct reading, compact and easy to use.

SPECIFICATIONS

Frequency: Fixed at 1,000 cps, ± 2%. Other frequencies 300 to 2,000 cps supplied on special order. Amplifier "Q" is 20 ± 5.

Sensitivity: 0.3 uv gives full scale deflection. Noise level to input equivalent is 0.04 uv.

Calibration: For use with square-law detector. 60 db level covered in 6 ranges. Accuracy ± 0.1 db per 10 db step.

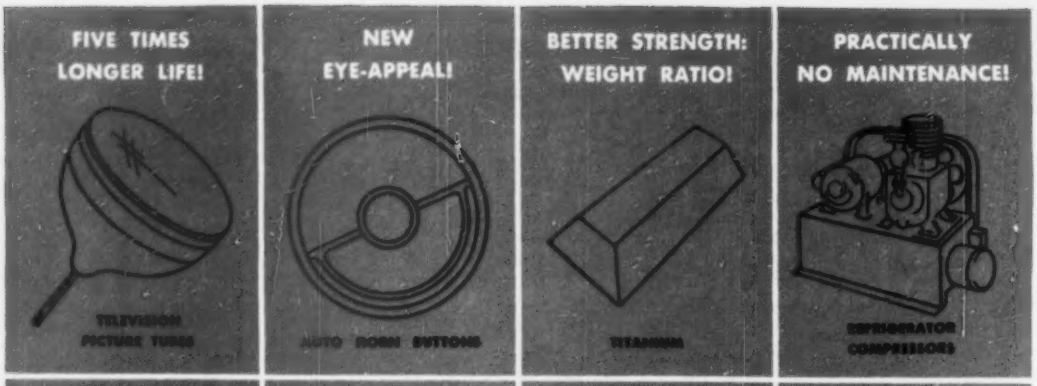
Gain Control: Adjusts meter to convenient level. Range is approx. 30 db.

Detector Input: Connects to Xtal rectifier or bolometer. Bias of 8 v. ± .5 v. delivers approx. 8.75 ma. to a 200 ohm barretter.

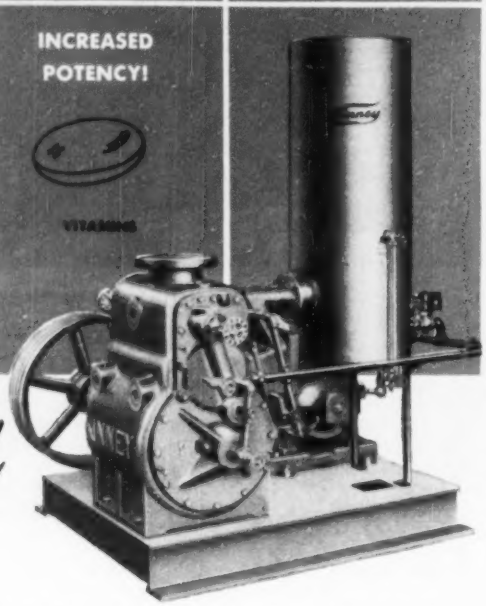
Size: 12" long, 9" wide, 9" high.

Data subject to change without notice.

hp laboratory instruments
FOR SPEED AND ACCURACY



The Touch of Gold



Vacuum processing with Kinney Pumps is "the touch of gold" in our times. Under the touch of low absolute pressures, scores of products today come to life with new qualities — product improvements that make sales curves show new vitality.

In the laboratory, Kinney Pumps have played a big part in the research and development of new vacuum products and processes. On the production-line, too, you'll find these same pumps . . . "sluggin' it out", day after day, year after year. People who know vacuum processing know that Kinney Pumps give low absolute pressures quickly — economically — dependably.

Single Stage Models are available in eight sizes: capacities from 13 to 702 cu. ft. per min. — for pressures to 10 microns Hg. abs. Compound Pumps are furnished in three sizes — capacities 5, 15, and 46 cu. ft. per min. — for test pressures to 0.5 micron Hg. abs. Send for Bulletin V45 — the complete story on Kinney Vacuum Pumps, Oil Separators, and Vacuum Pumping Accessories.

Kinney Manufacturing Company, 3565 Washington St., Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Houston, New Orleans, Philadelphia, Los Angeles, San Francisco, Seattle.

Foreign Representatives: General Engineering Co. (Radcliffe) Ltd., Station Works, Bury Road, Radcliffe, Lancashire, England . . . Horrocks, Roxburgh Pty., Ltd., Melbourne, C. I. Australia . . . W. S. Thomas & Taylor Pty., Ltd., Johannesburg, Union of South Africa . . . Novelectric, Ltd., Zurich, Switzerland.

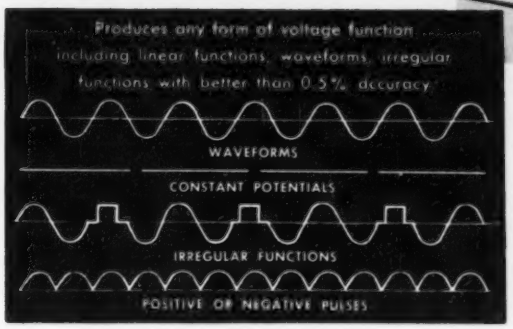
Making old things better
Making new things possible

KINNEY Vacuum Pumps

THE NEW

VARI-FUNCTION POTENTIOMETER

Any wave form at your FINGERTIPS!


Produces any form of voltage function including linear functions, waveforms, irregular functions with better than 0.5% accuracy
WAVEFORMS
CONSTANT POTENTIALS
IRREGULAR FUNCTIONS
POSITIVE OR NEGATIVE PULSES

TYPICAL APPLICATIONS

- Guided Missiles
- Position Indicator
- Gyroscopes
- Flight Control Instruments
- Gun Fire Controllers
- Marine Depth Sounding Apparatus
- Radar
- Electronic Computers
- Flow Controllers
- Flow Meters
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A revolutionary design of a non-linear adjustable potentiometer

This instrument comprises a helical resistance and a plurality of taps that can be quickly adjusted to produce or reproduce any desired voltage indication or output, as a function of angular displacement.

Voltage forms including linear functions, lines of constant potential, wave forms, and any irregular curves can be reproduced. The function form can be varied quickly by shifting the taps along a calibrated scale.

Available with shaft extension for external coupling and for fixed functions, as required.

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would freeze an eskimo

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SEND FOR THIS FREE SAMPLE FOLDER

Contains samples for you to test of the revolutionary development of Varflex laboratories . . .

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would roast the devil

. . . WON'T ROAST VARGLAS SILICONE

Electrical Insulating Tubing and Sleeving lead wire and tying cord

Efficient at 500° F. or more in some applications—yet completely flexible at —85° F. Resistant to moisture and lubricating oil—flame resistant and self-extinguishing—this pioneer silicone tubing and sleeving developed by Varflex is the *strongest of all accepted insulating materials.*

Varglas Silicone is a combination of *Varglas*—continuous filament Fiberglas; moisture and fungus proof; will not burn; strong and flexible at high and low temperatures; chemically inert . . . and *Silicone High Temperature Resin*—which has a natural affinity for Fiberglas; renders it abrasion-resistant, flexible and non-fraying. Normalizing process removes binder and organic inclusions from the Fiberglas; improves electrical qualities and allows uniform impregnation.

Investigate the NEW, low cost VARFLO Sleeving and Tubing if you do not have to allow for an unusually high operating temperature. Samples and prices on request. It's flexible. It takes rough handling without loss of dielectric. It won't fray out. Made with a Fiberglas braid, it won't support combustion—YET COSTS NO MORE THAN COTTON.

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Makers of Electrical Insulating Tubing and Sleeving

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Capacitors
Trimmers • Choke Coils
Wire Wound Resistors

BETTER 4 WAYS

- PRECISION
- UNIFORMITY
- DEPENDABILITY
- MINIATURIZATION

● The engineering laboratory is the alert guardian of **HI-Q** quality. No component can be put into production until it has proven that it meets **HI-Q's** exacting standards to the complete satisfaction of these technicians. It is their further responsibility to see that standards are rigidly maintained during production runs. In addition, **HI-Q** engineers are always available to work with your engineers in the development of components to meet your specific needs. Feel free to call on them whenever and as often as you see fit.

Don't miss the brand new **HI-Q** *Datalog. If you haven't received your copy, write to-day.*

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SALES OFFICES: New York, Philadelphia, Detroit, Chicago, Los Angeles

PLANTS: Franklinville, N. Y., Jessup, Pa., Myrtle Beach, S. C.

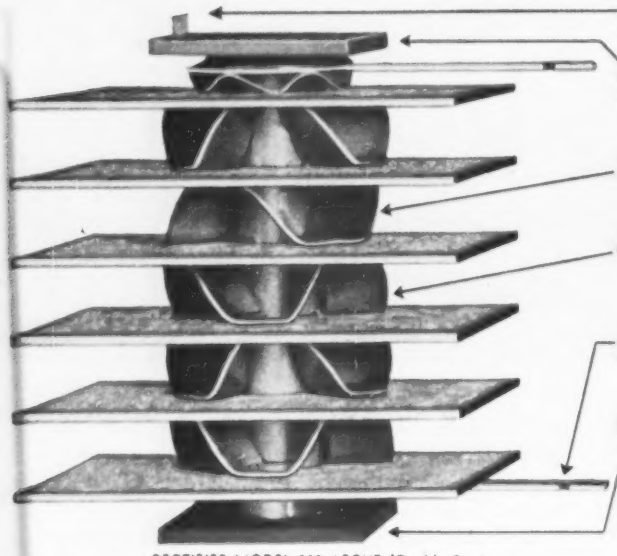
EXPORT ADDRESS: 41 E. 42nd St., New York 17, N. Y., U. S. A.

"Centre-Kooled"©

PAT. APPLIED FOR

SELENIUM RECTIFIERS

With All The Features You Have Been Asking For:



RECTIFIER MODEL 300 ABOVE (Double Size)
15 OTHER MODELS AVAILABLE

1 UNIVERSAL LOCATING PIN
Can be rotated in 90° steps on either side of the rectifier.

2 COLOR CODED
For instantaneous identification of rectifier polarity.

3 CENTER COOLING
Cooled to the "core" by revolutionary spacers.

4 SPRING LOADED
Each spacer acts as an individual spring to guarantee constant assembly pressure under all operating conditions.

5 NOTCHED LUGS
For ease of wiring. Hot tin dipped for ease of soldering.

6 HIGHER LEAKAGE RESISTANCE
Protective end plates of XXP Bakelite insure highest possible resistance to ground under all operating conditions.

7 MODEL NUMBERS
Easily recognized—indicate current rating of rectifiers in milliamperes.

"Centre-Kooled"© SELENIUM RECTIFIERS

Give:

- ***Longer Life***
- ***Lower Temperature***
- ***Ease of Installation***

For Further Information or Engineering Service, Write Dept. E

PACKAGED FOR DISTRIBUTORS

Sarkes Tarzian *RECTIFIER DIVISION*

INC. 415 North College Avenue, Bloomington, Indiana

High-Accuracy Beckman pH Meter† relies on D-H ALLOYS

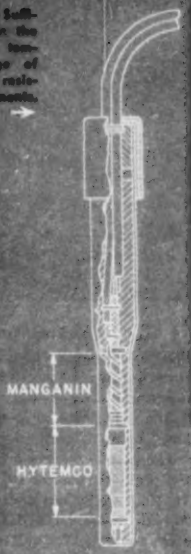
FLOW CHAMBER — with resistance bulb thermometer and electrodes.
BECKMAN MODEL R pH INDICATOR containing amplifier and precision measuring circuits.

In large industrial installations, where pH control must be continuous or automatic, or both, the temperature of process solutions has to be obtained continuously, in order to compensate for effects of temperature change upon pH.

To accomplish this, the Beckman Model R Automatic pH Indicator provides a flow chamber, or immersion assembly, containing a resistance bulb thermometer in addition to the glass and calomel electrodes used in measuring pH. This resistance thermometer is an element in the feed-back circuit of a stable DC amplifier whose sensitivity is accordingly varied in proportion to the absolute temperature of the process solution.

To assure complete accuracy, the thermometer of the Beckman Model R pH Indicator is wound with D-H HYTEMCO* wire, supplemented with D-H MANGANIN. The high temperature coefficient of HYTEMCO makes it eminently suitable for this application; and the absolutely uniform behavior of this alloy, thruout a wide temperature range, helps the indicator to record pH values with utmost fidelity. The supplementary winding of D-H MANGANIN is required in order to raise the resistance of the assembly to a specific circuit value without increasing the increment of resistance with temperature. This the MANGANIN does very effectively.

RESISTANCE BULB THERMOMETER — Sufficient Hytemco wire is used to obtain the necessary resistance value for the temperature range. A small percentage of Manganin is then added to bring total resistance of winding up to circuit requirements.



In addition to the desirable electrical characteristics of these D-H alloys, however, is the outstanding uniformity of the wire from spool to spool, and the quality "built into" it —as a result of exclusive Driver-Harris know-how and advanced melting, rolling and drawing techniques.

Special alloys for special uses is an important phase of our business. If you have been unable to obtain just what you are looking for, let us know your requirements. We'll gladly put our 50 years of experience at your disposal, and supply you with the alloy best suited to your needs.

†Product of National Technical Laboratories, S. Pasadena, Calif.

Makers of world-famous Nichrome and over 80 alloys for the electrical, electronic and heat-treating fields*

Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

Manufactured and sold in Canada by
The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

FIFTIETH ANNIVERSARY — SPECIAL PURPOSE ALLOYS SINCE 1900 — D/H — TRADE MARK REG. U. S. PAT. OFF.

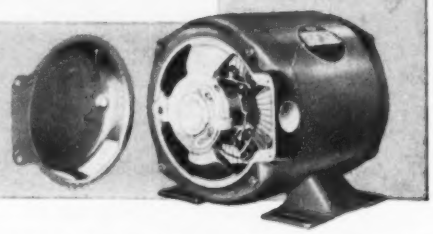
*T. M. Reg. U. S. Pat. Off.

Brown-Brockmeyer solves tough insulating problem

with

ROGERS DUROID PART

Rogers ability to fabricate this complex component in one piece saved the customer the problem of redesigning the part and complicating assembly with five individual pieces of insulation.



BROWN-BROCKMEYER required a deep drawn and shaped fibrous insulating part. It had been designed to cover a steel support housing for a commutator. The steel housing is used to hold a radial molded commutator for the newly designed "Dyna-Line" brush-lifting motor.

The problem was to find a material with the required electrical and physical characteristics and a fabricator capable of forming and shaping the part to design requirements. Rogers filled the bill on both counts. DUROID, a new Rogers material similar in electrical properties to vulcanized fibre, made the part possible. It could be drawn to the required depth — a virtual impossibility with any other fibrous sheet material. Our Fabricating Division's skill and experience met the challenge of producing this intricate piece with economy and speed.

You can apply this same high order of fabricating efficiency to your requirements for fibrous or laminated phenolic parts. Our range of high quality materials, our specialized knowledge, skills and facilities will SAVE YOU MONEY — AND GET THE JOB DONE.

Write for catalog describing Rogers Corporation's complete fabricating services.

FABRICATING DIVISION, DEPT. E

ROGERS CORPORATION

GOODYEAR, CONNECTICUT

ROGERS

SPECIALTY FIBRE PRODUCTS
ELECTRICAL INSULATING BOARDS AND PAPERS
DUROIDS • SHOE PRODUCTS

MOLDING AND LAMINATING PLASTICS
Boards • Blanks • Pre-shaped Preforms
High Strength Molding Compounds
Laminated Phenolics

COMPLETE FABRICATING SERVICES
ON FIBROUS MATERIALS AND
LAMINATED PHENOLICS

IT'S NEW...

IT'S DIFFERENT...

It's *GENERAL INDUSTRIES'* latest sound reproduction triumph

MODEL 250

TAPE-DISC Recorder Assembly

* **Records on tape**
* **Records on discs**
* **Plays back both**
* **Plays any 78 R.P.M. Record**

(*) When connected with the proper amplifier.

NOW . . . for the first time . . . General Industries offers you a revolutionary new type of recording instrument —*for both tape and disc use.* Here, indeed, is the answer to a long-standing need for an all-purpose recording unit inexpensive enough to be incorporated in moderately-priced home entertainment instruments.

Yet, despite its low cost, the Model 250 Tape-Disc Recorder offers many quality features . . . is built to the same rigid performance standards which characterize all GI *Smooth Power* products.

A new catalog sheet, describing all of the recording and play-back features of the Model 250, now is available. Write, wire or phone for your copy *today.*

The GENERAL INDUSTRIES Co.

DEPARTMENT B • ELYRIA, OHIO

..this letter speaks for itself!

Admiral Corporation
Mr. Hal Demering
Simpson Electric Company
5200 West Kinzie Street
Chicago 44, Illinois
Dear Hal:
This is to tell you how delighted we are here at Admiral with the new Model 303 Simpson Vacuum Tube Volt-Ohmmeter. It certainly is a versatile instrument for television servicing.
The large meter is very legible, and yet the instrument itself is a compact size. I particularly like the AC voltage range, which is the widest I've ever seen on this type of instrument.
Our service engineers think you've done a good job on the Operator's Manual, too, because it is both complete and concise.
Of course, we've used the Simpson Model 260 Volt-Ohm-Milliammeter for years. The "303" is a fine companion instrument to the "260".
Congratulations!
Sincerely yours,
ADMIRAL CORPORATION
W. J. Schinke
National Service Manager
WJSster

Model 303
VACUUM TUBE VOLT-OHMMETER

SPECIFICATIONS

DC Voltage
Ranges 1.5, 12, 60, 300, 1200 (30,000 with Accessory High Voltage Probe)
Input Resistance 10 megohms for all ranges
DC Probe with one megohm isolating resistor Polarity reversing switch

Ohms *Ranges* 1000 (10 ohms center)
100,000 (1000 ohms center)
1 megohm (10,000 ohms center)
10 megohms (100,000 ohms center)
1000 megohms (10 megohms center)

AC Voltage
Ranges 1.5, 12, 60, 300, 1200
Impedance (with cable) approx. 200 mmf shunted by 275,000 ohms

AF Voltage
Ranges 1.5, 12, 60
Frequency Response Flat to 100,000 cycles

Decibels
Ranges −20 to +3, −10 to +25, +4 to +37, +18 to +51, +30 to +63
Zero Power Level 1 M. W., 600 ohms

Galvanometer
Zero center for FM discriminator alignment and other galvanometer applications

R. F. Voltage
(Signal tracing with Accessory High Frequency Crystal Probe)
Range 20 volts maximum
Frequency Flat 20 KC to 100 M.C.
105-125 V., 60 cycles

Size
5¾"x7"x3⅞" (bakelite case). *Weight:* 4 lbs. *Shipping Wt.:* 6½ lbs.

Dealer's Net Price
Model 303, including DCV Probe, ACV—Ohms probe and Ground Lead—$58.75;
Accessory High Frequency Probe, $7.50;
Accessory High Voltage Probe, $14.85
Also available with roll top case, Model 303RT—$64.75

Simpson ELECTRIC COMPANY
5200 WEST KINZIE STREET, CHICAGO 44, ILLINOIS • IN CANADA: BACH-SIMPSON, LTD., LONDON, ONTARIO
Phone: COlumbus 1-1221

ASK Erie RESISTOR . . .

. . . About *Custom Designed* Trimmers

Pictured above are several custom designed trimmers that incorporate the elements of standard Erie Disc and Tubular Ceramicon Trimmers. Each has been developed for a specific purpose, and each does its job efficiently and economically. Proper design and precision manufacturing, plus our years of experience, are the keynote to Erie quality.

Look at these units carefully. They should suggest the possibility of using Erie Resistor know-how and facilities to make your equipment more compact and more efficient.

Erie has the most complete trimmer line in the industry. We want to work with you in adapting them to your requirements. Inquiries should specify complete mechanical and electrical requirements.

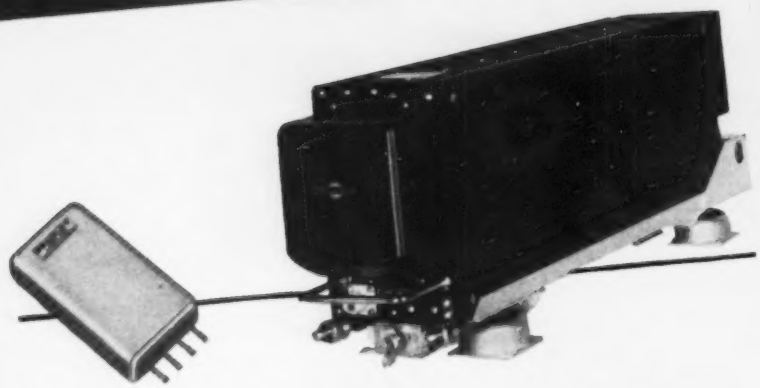
1. Standard Style TD2A Dual Trimmer with mounting pillars.
2. Special ribbon type terminals on standard Style TS2B Trimmer for direct connection to other components.
3. Compact Trimmer—Capacitor—Resistor—Coil Design. A complete oscillator unit.
4. Where special mounting is desired, standard Erie Style TS2A and Style 557 Trimmers can be supplied mounted on brackets.
5.
6.
7. Two trimmer elements become an integral part of this coil form and I. F. top section.
8.
9. Special bracket and terminal arrangements or dual trimmer unit.
10. A compact pluggable assembly for mounting a trimmer in parallel with a plug-in crystal.
11. Special tubular ceramic trimmer and variable inductance having one common terminal.
12. Special steatite tubular dual trimmer.
13. Standard Erie Style 557 Trimmer with special bent rotor terminal.

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND • • • TORONTO, CANADA

A BRADLEY CASE HISTORY



BRADLEY RECTIFIER SOLVES DEMODULATING DIFFICULTY

Collins Radio Company, in its 51R-2 aircraft receiver, uses a Bradley hermetically sealed vacuum-processed selenium rectifier for demodulating an FM signal which provides navigation information in the newly developed omni-range system.

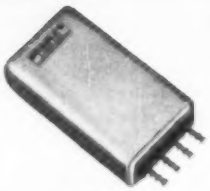
"We were," says Collins, "at one time having considerable trouble in this circuit. Your rectifiers remedied this situation completely. They have contributed a great deal in enabling us to obtain the required performance in our 51R-2 receiver.

"The characteristics of the rectifier are retained even under the extreme variation of temperatures stipulated by the Civil Aeronautics Administration in testing suitability for use in scheduled airlines service."

Through its exclusive vacuum process, Bradley has solved the problem of producing selenium and copper oxide rectifiers that are uniform and consistently true to rating. For improved power conversion in your product, consult Bradley engineers. They can help you obtain the right rectifier for your application.

THE **BRADLEY** LINE

SELENIUM RECTIFIERS
•
COPPER OXIDE RECTIFIERS
•
SELF-GENERATING PHOTOCELLS



SELENIUM SEAL

SPECIFICATION DATA

1. Reverse current at 150 volts DC 15 microamperes maximum at plus 72° C. to minus 50° C.
2. Forward current at 42 volts DC from 700 microamperes minimum to 2 milliamperes maximum at plus 72° C. to minus 50° C.
3. The unit shall be capable of operating continuously within limits at 95% relative humidity.

BRADLEY LABORATORIES, INC. 82 MEADOW STREET NEW HAVEN 10, CONN.

Induction Oscillator

Now an induction oscillator which is rugged and dependable is available at a moderate price! HAYDU BROTHERS' answer to your problem in brazing, annealing and hardening—where localized and zonal heating is important—can be solved with this machine of infinite uses.

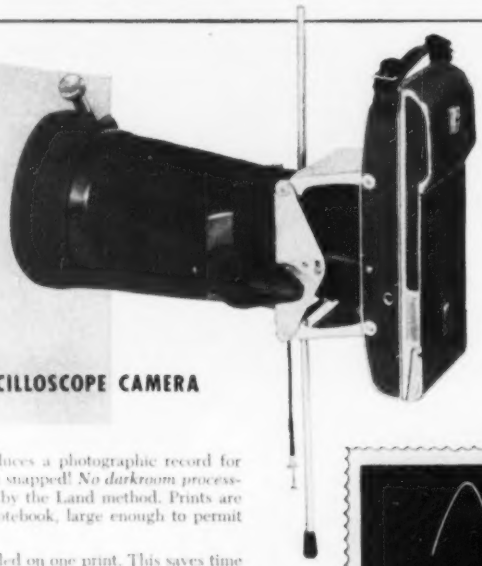
Maintenance difficulties are overcome easily in the induction oscillator, as Bill Klinder, with his many years of experience in electronics, gave every consideration to make each part readily accessible. Replacement and repair is simplified by listing all parts and their functions in a schematic diagram.

We welcome the opportunity for the engineering staff to analyze any particular problem at no cost or obligation and will gladly work on specified samples. Our production plant for brazing is also equipped to undertake consignments where the expense of a complete unit cannot be met. The induction oscillator can be built to any power specification to meet individual needs.

HAYDU BROTHERS
PLAINFIELD NEW JERSEY

Now!

A Photographic Record of Oscilloscope images in <u>One Minute</u>



FAIRCHILD POLAROID OSCILLOSCOPE CAMERA

This new inexpensive oscilloscope camera produces a photographic record for engineering study *one minute* after the shutter is snapped! *No darkroom processing is required.* It's all done within the camera by the Land method. Prints are 3¼ x 4¼ — small enough to mount easily in a notebook, large enough to permit accurate evaluation.

Two traces — one above the other — can be recorded on one print. This saves time and film as well as facilitating comparison runs. *Writing speeds* ranging up to 1 in/μsec with an accelerating potential of 3000V have been recorded. With higher potentials, speeds to 50 or 60 in/μsec can be recorded.

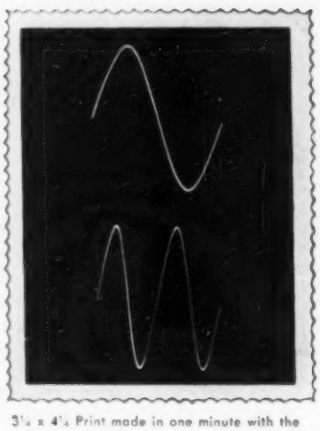
By observing the trace through the viewing port, the operator can record repetitive phenomena as he wishes. Transients are recorded by "bulb" or "time" exposure. The tube face is so well shielded that records can be made in bright light.

Designed for easy installation on any standard 5-inch oscilloscope, the new Fairchild-Polaroid Camera consists of a *scope adapter*, a *light-tight hood* with viewing port, and a *Polaroid-Land Camera body.*

A specially designed f/2.8 lens with a between-the-lens shutter makes possible sharp, fully exposed photos. A two-position shift device moves the camera to permit two exposures on one print. The whole assembly is lightweight and easy-to-handle.

The required film takes 16 exposures to the roll and may be obtained at small cost in almost any photographic supply store.

For more data, write to 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.



3¼ x 4¼ Print made in one minute with the new Fairchild-Polaroid Oscilloscope Camera.

Fairchild
CAMERA AND INSTRUMENT CORPORATION

The New Fairchild-Polaroid Oscilloscope Camera is available at these outlets:

Tektronix Inc., Portland, Oregon
Electronic Tube Corp., Philadelphia, Pa.
Browning Laboratories Inc., Winchester, Mass.

FOR BETTER TUBE PERFORMANCE

NOW—MORE THAN EVER BEFORE —ELECTRICAL ALLOYS *MUST BE BETTER*

The critical requirements of television circuits demand better tubes with finer electrical alloys — alloys that are superior electrically, chemically and in physical properties. A logical source for metals to meet these new standards is the Wilbur B. Driver Company, largest producer of carbonized nickel ribbon and filament alloys *for more than twenty years.* Inquiries concerning critical tube applications will receive prompt, capable attention. Write today, outlining your requirements — there is no obligation.

WILBUR B. DRIVER CO.

150 RIVERSIDE AVE., NEWARK 4, NEW JERSEY

the New
PYRAMID
"Humidi-Seal"
(TUBULAR PAPER CAPACITOR)

Ruggedly built to withstand undue vibration and rough handling

Outer tube plastic impregnated to prevent moisture absorption

Light outer coat of high-temp wax provides double protection

Each end plastic sealed against moisture

Leads anchored securely in solid plastic end

Type 85TOC "Humidi-Seal" capacitors are specially designed for 85° C. operation, even in the most humid atmospheres, and will meet the severe present-day demands of endurance in television receivers, auto radios, etc.

WRITE FOR COMPLETE LITERATURE

Representatives and Distributors throughout the U.S.A. and Canada

PYRAMID

PYRAMID ELECTRIC COMPANY
155 Oxford Street
Paterson, N. J., U.S.A.
TELEGRAMS: WUX Paterson, N. J.
CABLE ADDRESS: Pyramiduse

BUSINESS BRIEFS

By W. W. MacDONALD

Image Orthicons and associated apparatus are expensive to maintain. So many television stations rehearse shows with the cameras dead, a practice that prohibits monitoring and later permits visual fluffs to get on the air.

Some of the new closed-circuit industrial television systems (about which you will hear more from us in the months ahead) are relatively inexpensive to own and operate, so we suspect that they may soon come into use in tv studios for rehearsals.

Black Gupp of some kind has been sprayed on the face of some clear-glass television picture tubes to clear out stock in view of competition from black-face types. Also, there are rumors of possible price reductions on round-tube types in anticipation of increased popularity for the rectangular variety.

Both trends will bear watching.

Upping of television users from small screens to large screens is already underway in certain markets. Replacement business is already with us.

Cryptic Statement to stockholders by Harry Cohn of Columbia Pictures Corporation reads as follows: *"In the event a point is reached where television should fit into our operations on a basis we deem desirable, we will be in a position to take advantage of any change."*

Experienced as we are in the coining of neat phrases, we doubt if we could have done better ourselves, and further details from Hollywood are awaited with the keenest interest.

Police Vehicles licensed to use radio transmitters total approximately 40,000, according to General Electric. Approximately 13,000 cars are yet to be licensed and these will have equipment in operation within three years if the rate of growth continues as in the past few years. G. E. estimates that police departments will spend $5,450,000 on radio equipment in 1950.

Receiver Sales by licensees during 1949 totalled 13,237,098, worth $823,395,645. Here's the way the total broke down:

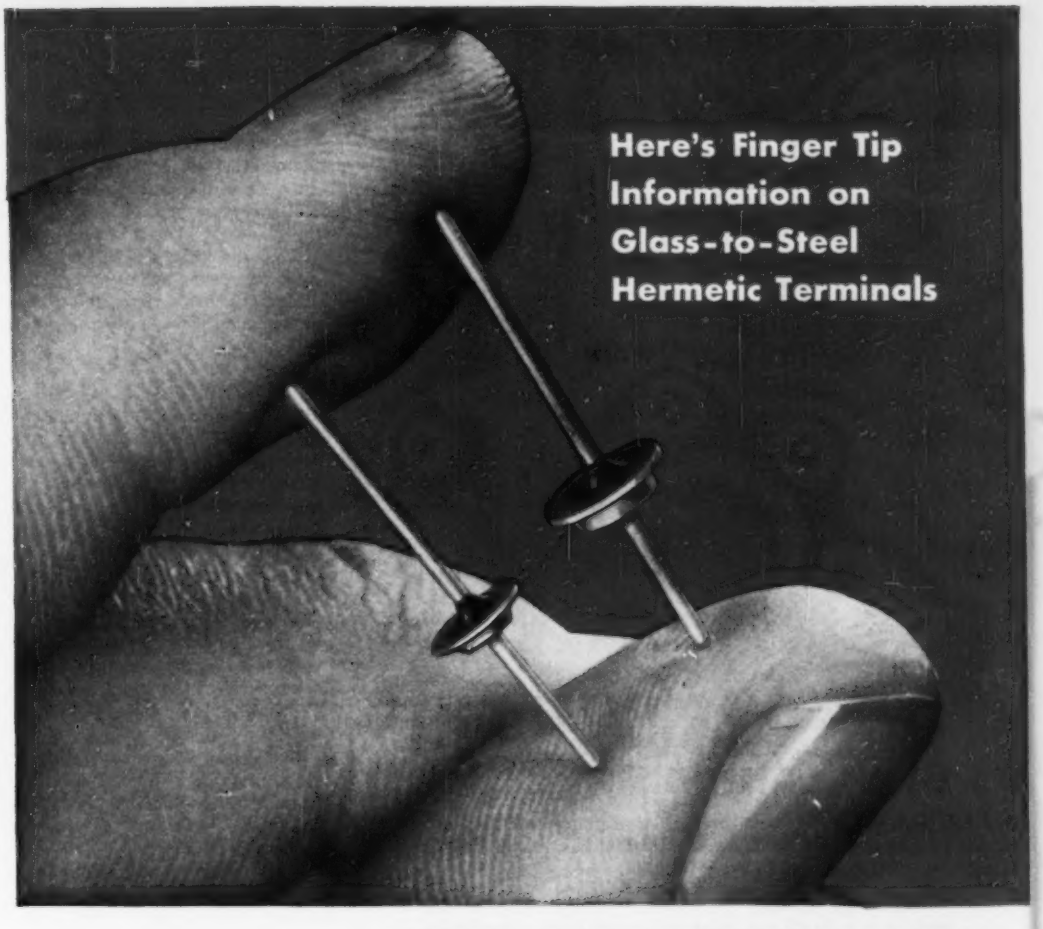
Type	Units	Dollars
Electric		
Table (under $12.50 billing price)	2,149,469	$22,434,688
Table (over $12.50 billing price)		
A-M	1,540,558	27,972,101
A-M/F-M	341,214	10,561,344
F-M (including converters)	36,650	1,043,125
Consoles		
A-M	13,922	606,062
A-M/F-M	16,431	1,335,382
Table-Radio-Phonos		
A-M	360,229	12,516,360
A-M/F-M	16,700	879,015
Console-Radio-Phonos		
A-M	146,717	10,929,486
A-M/F-M	439,910	49,863,573
Battery		
Portable A-C/D-C	1,334,222	24,966,858
Table	89,175	1,663,580
Consoles	1,064	98,103
Auto	3,389,168	100,351,280
Television		
Converters	1,860	519,654
Radio Table Models	1,629,450	251,815,187
Radio Consoles		
Direct Viewing	917,342	194,406,965
Projection	12,702	4,981,847
Radio Phonos		
Direct Viewing	321,416	94,361,547
Projection	902	521,741
Phonographs		
Phono only	383,791	7,346,550
With radio attachment	33,468	348,430
Without Cabinets		
A-M	18,968	429,216
A-M/F-M	16,344	860,555
Television	25,426	3,482,996

CAA has just awarded the largest contract in its history, for 450 distance - measuring - equipment ground stations, to Hazeltine Electronics. Price: $4,210,750. Delivery: November 1950 for the first unit, five more in March 1951 and 40 per month by June 1951.

The contract represents part of CAA's billion-dollar, fifteen-year air navigation equipment program.

All 84,000 Amateurs are not using the band on which you operate. It only seems that way.

Brazil is modernizing its communications system. First step in the program is the placing of a contract with Byington & Company for $1,500,000 worth of telegraph lines and associated facilities. Byington has retained Stand-



• The trend toward hermetic sealing in all phases of electrical manufacturing is gaining impetus. Fusite has pioneered in the field of glass-to-steel hermetic terminals for use in fusion sealing—the only truly hermetic process.

• We have prepared a brochure crammed full of illustrations, specifications, diagrams, and facts about the Fusite wide line of single and multiple electrode terminals.

• We assure you that regardless of your present level of knowledge concerning glass-to-steel terminals, you do not have a complete or accurate picture of the production possibilities of fusion sealing until you know the Fusite story.

Write today for your copy of this literature, to Dept.-E.

TERMINALS ILLUSTRATED: 104SW, Left, 105SW, Right.
Miniature—Straight Wire—Single—Glass-to-Steel Hermetic Terminals.

INSULATE ELECTRICALLY
GLASS TO METAL
FUSITE
TERMINALS
PROTECT PRODUCT PERFORMANCE
SEAL HERMETICALLY

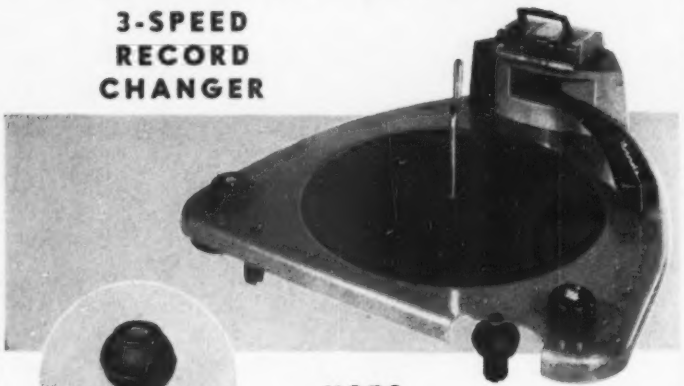
THE FUSITE CORPORATION

CARTHAGE AT HANNAFORD, NORWOOD, CINCINNATI 12, OHIO

SHOCK AND VIBRATION NEWS

Motorola

3-SPEED RECORD CHANGER



USES

BARRYMOUNTS

FOR ASSURED CONTROL of SHOCK and VIBRATION

For full, undisturbed enjoyment of the fine music reproduction offered by recent advancements in recorded music, the Motorola RC-36 record changer plays automatically at 33⅓, 45, and 78 RPM.

To eliminate speaker feedback, minimize rumble, and reduce the shock and noise of record drop, the chassis of the Motorola record changer is supported by four BARRYMOUNTS.

The control of shock and vibration, thus obtained, improves over-all performance by overcoming secondary effects detrimental to product acceptance.

The Type 371 BARRYMOUNTS used are designed for sub-assembly to the chassis as shown above. The free ends of the mounts drop into holes in the motor board. Retainer cones, that expand the straight shank of the BARRYMOUNT when upward force is applied, provide a self-captivating feature that speeds assembly.

Free Catalogs give dimensions and load ratings of stock BARRYMOUNTS. Catalog 502 covers aircraft applications. Catalog 504 covers industrial and general-purpose mountings. WRITE TODAY to

THE BARRY CORP

Main Office 177 Sidney St. ● Cambridge 39 Massachusetts

New York · Rochester · Philadelphia · Washington · Cleveland · Dayton · Chicago · Minneapolis · St. Louis · Los Angeles · Toronto

ard Electrica, S. A. (an associate of IT&T) as a consultant.

Machine-Tool Programming by automatic electronic means must provide the absolute maximum of flexibility, says R. N. Eck of Cutler-Hammer. The time required to set up the program, and the time required to change from one program to another, is of the utmost importance to industry, he points out.

As Near As We Can Tell, induction heating is about four times as big a business as dielectric heating dollarwise at the present time. The gap will, however, be substantially narrowed in the next few years.

Speaking Of R-F Heating, the FCC regulations make the user responsible for interference but we note in our travels that when equipment kicks up a fuss among other services the manufacturer is almost invariably called in to fix it.

European Countries receiving ECA assistance are rapidly improving their ability to deliver electronic apparatus. Here, according to McGraw-Hill World News correspondents, is the picture overseas:

Country	*Commodity*	*Delivery*
Austria	Radios and parts	Immediate
	Telephone accessories	3-6 months
	Telephone-telegraph stations	1 year
	Tubes	3-6 months
Belgium	Radios and parts	Immediate
	Telegraph accessories	1 year
	Telephone accessories	1-6 weeks
	Telephone exchanges	1 year
	Telephone switchboards	3-8 months
	Teleprinters	2-3 months
	Teleprint exchanges	1 year
Denmark	Measuring instruments	1-2 months
	Radio equipment (f-m)	4-6 months
	Telegraph accessories (automatic)	3-4 months
	Telephone parts	2-8 months
England	Radio, tv and electronic apparatus	Immediate — 18 months
	Tubes (general)	Immediate
	Tubes (cathode-ray)	3-6 months
France	Capacitors (radio)	1 month
	Radios	Immediate
	Speakers	2 months
	Telephone equipment (carrier)	6-12 months
	Telephone exchanges	1-2 years
	Telephone switchboards	3-12 months
	Tubes	Immediate — 3 months
Germany	Radios	1-3 months
	Recorders (magnetic tape)	1-4 months
	Telephone exchanges	3-9 months
	Teleprint exchanges (manual)	3-6 months
	Teleprint exchanges (automatic)	6-9 months
	Teleprinters	Immediate — 3 months

	Transmitters (radio)	6–12 months
	Tubes	1–2 months
Italy	Amplifiers (audio)	Immediate
	Radios and parts	Immediate
	Telegraph accessories	Immediate
	Telephone equipment	Immediate
	Transmitters (small, radio)	Immediate
Netherlands	Capacitors, resistors	3–4 months
	Magnets (permanent)	Immediate — 2 months
	Magnetic materials (low-loss)	3–4 months
	Measuring equipment	Immediate
	Radios	Immediate — 3 months
	Record players, pickups	Immediate — 3 months
	Recording equipment	1–3 months
	Rectifiers (telephone)	2–6 months
	Relays, recorders, counters	Immediate — 4 months
	Servicing equipment (radio)	Immediate
	Signal equipment	Immediate — 4 months
	Sound equipment	Immediate
	Studio equipment (radio)	6–15 months
	Telephone equipment (carrier)	6–15 months
	Telephone equipment (general)	6–15 months
	Telephone exchanges (automatic)	6–15 months
	Television receivers	Immediate — 6 months
	Transmitters (a-m, f-m)	6–15 months
	Transmitters (television)	6–15 months
	Tubes (television)	Immediate
	Tubes (telephone)	Immediate
	Tubes (transmitting)	Immediate
	Tubes (receiving)	Immediate
	Tubes (uhf)	Immediate
Sweden	Radio, tv and electronic apparatus	Immediate — 18 months
	Tubes (general)	Immediate — 6 months
	Tube (cathode-ray)	Immediate — 6 months
Switzerland	Intercommunication apparatus	6–12 months
	Radios and parts	1 month
	Signalling and detection apparatus	4 months
	Telemetering and remote control	6 months
	Telephone apparatus	1–12 months
	Telephone equipment (carrier)	8–14 months
	Teleprint exchanges (automatic)	6–12 months

A New Subdepartment, *Shop Shortcuts,* made its bow in ELECTRONICS last month, and the second installment appears on p 184 of this issue. It was started on the theory that there is more to our business than just circuits; many subscribers are interested in the mechanics of laying out, producing and testing electronic apparatus.

A new department is never easy to get rolling; authors just don't know that the editors are interested in their wares until they are told. So we're taking this means of telling them . . . we are interested.

A Manufacturer we know has his plant on Skunks Misery Road. If anybody else has a trickier address we would like to know it.

G. B. B. M. Sutherland, in a recent speech, used the following limerick:

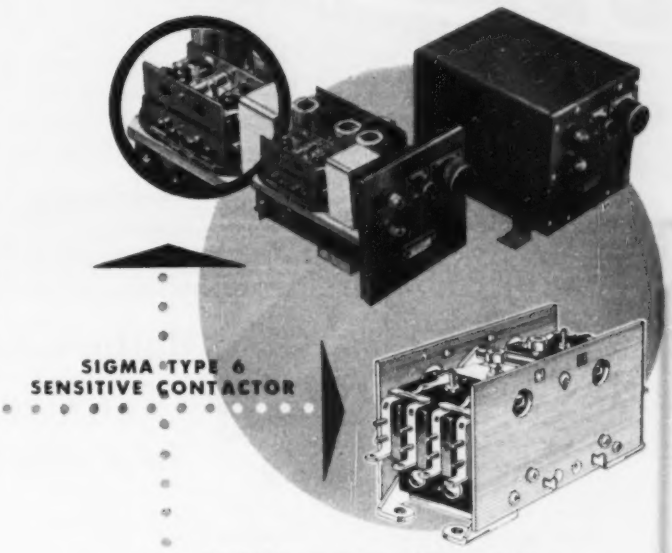
Mr. Langley invented the bolometer
Which is really a kind of thermometer,
That will measure the heat
From a polar bear's seat,
At a distance of half a kilometer.

The piece is hereby recorded for posterity.

NEW AiResearch*

ELECTRONIC BRAIN

DELIVERS ITS ANSWERS THROUGH—



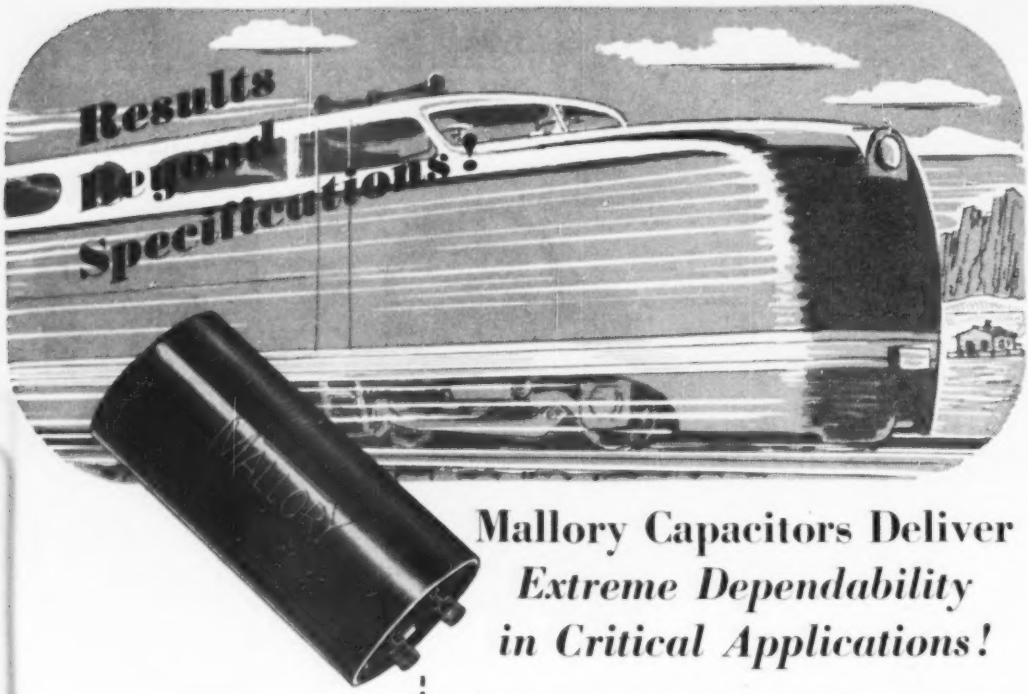
THE BRAIN — An electronic regulator system designed by Airesearch to meet the rapidly changing temperature conditions being encountered in today's high-speed aircraft. It provides in a small, light-weight package the control sensitivity and anticipation necessary precisely to control temperatures in an aircraft climbing from sea level to 40,000 feet in less than five minutes — or diving at supersonic speeds. It receives signals from a number of different temperature pickups (located in the ambient air stream, mixing duct and cabin) and computes from these data the required heat delivery to provide stable and constant cabin temperature.

THE RELAY — couples the solution computed in the "Brain" to the electrically actuated hot and cold air supply controls. A Sigma Series 6FX polarized 3-position sensitive contactor, it acts in a manner analogous both to an amplifier and to a discriminator. With two distinct operated positions and a third neutral or unoperated it permits the "Brain" to select either increase, no change or decrease in heat delivery to the cabin. As a result precise control is possible and yet the system is able to remain inactive and quiet when stabilized. Without a 3-way output made possible by a relay of this kind similarly close control could be achieved only by some form of pulsing system placing much more severe demands upon the life of all components.

Relays of this type are available from Sigma with contact combinations up to 4-pole; with single or double windings, and various sensitivities. They are furnished either open or hermetically sealed and by reason of balanced armature, substantial contact pressure and magnetic force are highly effective in severe environments. A more complete description and a listing of available standard types is contained in our catalog. The catalog also contains information on several other unique relays the properties of which may merit your attention. It will be mailed upon request.

*AiResearch, Los Angeles 45, California

SIGMA Instruments, Inc.
SENSITIVE RELAYS
62A Ceylon St., Boston 21, Mass.



Mallory Capacitors Deliver *Extreme Dependability in Critical Applications!*

MALLORY NP CAPACITORS

Mallory NP Capacitors are non-polarized and designed for heavy-duty applications where extreme dependability is essential. Priced competitively at ordinary capacitor levels, they are ideal for controls and other unusual circuits. Write for your copy of the Mallory NP Capacitor data folder.

Long trouble-free service has become so synonymous with Mallory Capacitors that customers have come to assign critical responsibilities to them without hesitation.

For example . . . a complex rpm control for diesel-electric locomotives. The failure of a single component would stall the train, blocking rail traffic for hours. For absolute safety and dependability, the manufacturer specified Mallory NP Capacitors in this control.

The Mallory-originated NP Capacitor is widely used in such important applications. This complete confidence is the result of years of *demonstration* of Mallory superiority. Yet Mallory Capacitors cost you no more.

That's results beyond specifications!

And whether your problem is electronic or metallurgical, what Mallory has done for others can be done for you!

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SERVING INDUSTRY WITH

Capacitors	Contacts
Controls	Resistors
Rectifiers	Vibrators
Special Switches	Power Supplies

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CROSS TALK

►**DOTS** . . . As this is written, Peter Goldmark has just reported to the FCC the successful application of dot-interlace to the CBS system of color television. We refrain from taking sides in the color-tv question while the matter is "in the courts". But we see no reason for refraining from expressing pleasure over the fact that the ingenious dot method, which improves resolution nearly two to one without increasing the bandwidth, has now been applied to two of the three contesting color systems, those proposed by RCA and CBS. All of which serves as justification for rereading Wilson Boothroyd's two-part article on dot television systems which appeared in the December 1949 and January 1950 issues of this magazine.

It is dangerous to take a stand on technical issues while they are still in a state of rapid flux. But synchronized time-multiplex transmission (the dot method) is so powerful a tool, has such a far reaching effect on spectrum economy, that we feel a voice should be raised. So here goes: *No system of television, whether in color or in black-and-white, should henceforth be introduced to the public unless dot-interlace is employed. Moreover, dot-interlace should be introduced as soon as possible to the 525-line black-and-white system now standard in this country.* Dot-interlace could be introduced without impairing the performance of, and without requiring any change in, any existing receiver, and it would make possible substantially improved performance in receivers of the future.

Any sweeping recommendation on television standards these days is an invitation to a storm of protest, if obsolescence is to be hastened by the proposed change. But dot-interlace by time multiplex can be introduced without obsolescence of any equipment.

Any bugs in this proposal are certain to be called to our attention, pronto. If they come to light we'll pass them on.

►**KUDOS** . . . The exploration of the moon's sub-surface temperature by microwaves (*Crosstalk*, January) has been mentioned by Harlow Shapley as among the ten astronomical events of the year 1949. Dr. Salisbury has promised us a paper on the subject, soon's he get's around to it.

►**SILK** . . . We are continually amazed at the full circles through which electronic developments ultimately travel. First case: the connection between electricity and light was discovered by the British telegrapher May, who discovered the photoconductive property of selenium in 1873. Now in 1950 comes the vidicon (p 70), most sensitive of all television camera tubes, and what does it turn out to be? A photoconductive cell, and a selenium cell at that. Second case: The first recorded instance of man-made static electricity, according to the Greek records, was that produced when silk was rubbed on amber. Three milleniums later, A. D. 1950, we learn that a new source of interference to television reception has been isolated after an exhaustive search. According to "Free Grid" of *Wireless World*, a momentary snow storm on the tv screen has been found to accompany the nearby, rapid removal of silk or nylon hose. A phenomenon, indeed! The surprising thing is that the interference was ever noticed, under the now-identified circumstances.

►**DEPTS** . . . Conversation with subscribers in half-a-dozen cities leads us to believe that quite a few have not yet discovered the department *Business Briefs* appearing immediately ahead of this page. If you are one of those that have overlooked it, we urge you to read this department that briefs facts and figures of interest to men who design, produce and sell electronic equipment.

Two other departments have apparently suffered because of their position, rather than any lack of reader interest, *New Books* and *Backtalk*. We've given them a break this month by starting them off with a full page immediately after the other departments.

ELECTRONIC MACHINES for Business Use

A machine that satisfactorily solves differential equations will not necessarily perform every-day clerical work. The circuit principles are applicable, but much engineering must be done before the office-equipment market can be tapped

By W. B. FLOYD

Research Division
Sears, Roebuck and Co.
Chicago, Ill.

BUSINESSMEN, as well as mathematicians, are fascinated by the possibilities of electronic computation. What they see, primarily, are payroll savings. Of secondary importance, they see the possibility of securing additional facts about their businesses.

When a businessman reads in the newspapers about a machine that will do in thirty minutes what it would take thirty people a month or more to do manually, he naturally asks, "When can I get one of these machines!" He may not think to ask whether or not the machine will actually do the particular clerical jobs that have to be done in his office. He is likely to assume that any machine that will solve difficult mathematical problems will do ordinary clerical work with ease.

This assumption is understandable. The principles of electronic computation are applicable to much of the clerical work encountered in business. Automatic electronic machines undoubtedly will effect a clerical revolution. But some more engineering will have to be done before that happens. A machine that will solve differential equations is not necessarily a machine that will do the everyday paper work of business concerns, and do it economically.

The engineering that remains to be done, before the market for automatic clerical machines can be tapped, is by no means all electronic engineering. First, an industrial engineering job must be done. Business problems must be understood in detail before ideal machines for their solution can be built.

The General Pattern

No two companies have quite the same clerical problems. This fact has been the despair of more than one office-equipment salesman. Nevertheless, a common pattern is discernible in most clerical work.

The pattern starts with the creation or receipt of an original document. A purchasing agent notes an item to be bought; a receiving clerk lists incoming merchandise; a salesperson writes a sales check; a meter reader writes down some numbers. Or a purchase order, subscription, remittance or complaint is received. Millions of entries and papers such as these are the starting point of virtually all of the clerical work that is done in business. They are the input of whatever system is used to ship merchandise, charge customers, maintain stocks, schedule production and account for income and outgo.

The remaining steps are internal to the system itself. They almost invariably include:

One or more lookups, to secure additional information or to check information that is shown on the original document.

A few simple calculations, such as totaling an account or extending an invoice.

Recording the transaction, often under not one but several captions.

Typing final documents such as purchase orders, shipping papers, voucher checks, acknowledgements and hosts of similar papers.

Summarizing the data that has been recorded from the constant flow of business papers. Most accounting and statistical work belongs in this category.

If you think of almost any clerical procedure you happen to be familiar with, you will see that it does involve all of these steps. And in most cases, sorting, lookups, posting and typing far outweigh the arithmetical work that is done.

With the foregoing pattern of clerical work in mind, we can now see some of the important points of contrast between the mathematical computers that have been built and

The CUSTOMER Speaks

BUSINESS BRIEFS (p 60, March) recently called attention to the fact that an

"Important trend everywhere in evidence is an engineering struggle to combine the functions of electronic measuring - telemetering - calculating - indicating - recording devices with those of the garden variety of business machines."

It was pointed out that

"What is needed is a bridge between the two devices, one that need not be monitored by human hands."

This article, by Mr. Floyd, tells what a typical businessman expects of design engineers

Clerical help in one of many departments of a big business concern, typical of the offices where completely automatic electronic machines are needed

the clerical machines that will be built. These contrasts bring out some of the still-unsolved problems in building an ideal clerical machine.

Machines vs Computers

The Input Problem. One fundamental difference between mathematical and clerical work can be stated this way: While mathematicians often have to perform a great many complex operations on a relatively small amount of data, clerks in business offices must perform a few relatively simple operations on a vast amount of data.

Two implications as to machine design are immediately apparent. Input and output capacities assume greatly increased importance. Computation assumes less importance.

To handle clerical input economically, we must do more than merely use the fastest possible keyboards. Every conceivable means must be found to eliminate the manual keyboard altogether, or to hold the required number of key depressions at an absolute minimum and so minimize manual labor.

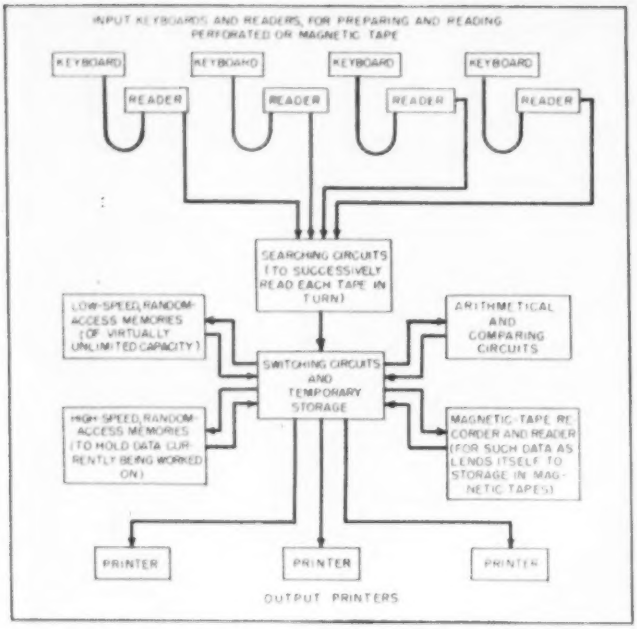
One way to reduce key strokes is to record manually only reference numbers, relying upon the machine's memories to supply all of the remaining data that is regularly associated with these reference numbers. For example, the price and description of a product are usually associated with a stock number. Similarly, the name and address of a vendor or customer can usually be associated with a vendor number or customer number.

Better than reducing manual input is to eliminate it altogether, by producing original documents in machine language to begin with. Equipment recently developed for the retail garment trade illustrates this principle. The marking tickets that are placed on garments are prepared by a special machine that perforates as well as prints code numbers on the tickets. Thus the garment ticket stub, which is removed when the item is sold, can be automatically read by the machines that record and summarize sales.

Much thought is being given to more generally useful means of producing original documents so they can be read automatically. The problem is one of inter-company standardization rather than of finding technical solutions to the problem. There is a need for more standard business documents that can be read mechanically as well as visually. When it costs nearly as much to put data in such form that a machine can use it as it would cost to produce the final documents themselves by manual means, nothing is gained by mechanization.

The Output Problem. The output problem cannot be solved in quite the same way as the input problem. Our whole purpose is a big output of invoices, purchase orders, receiving records, shipping papers, payment vouchers and summary reports. What we must do here is to speed up the output device itself.

A better solution must be found than that of driving electric typewriters automatically. No matter how fast they are driven, we are still printing only one character at



Basic components of the desired electronic machine for general business use

a time. Output printers for commercial use will almost certainly have to be of the line-at-a-time type. Perhaps several lines, or whole documents, will be printed at a single impression. Over 1,000 lines per minute is considered a worthy goal by some engineers who are working on output printers.

Selective Memories. Another basic contrast between most mathematical and clerical problems is the contrast between a batch of work and a flow of work. A big statistical problem constitutes a batch of work. Business documents, like the assembly lines to which they are tied, constitute a flow of work.

Preparing 10,000 invoices may be comparable, in machine time, to solving a single problem in mathematical physics. Yet, in addition to differences in the volumes of input and output, there is another fundamental difference between the two undertakings. All of the data for the mathematical problem can be assembled, in predetermined order, and handled as a unit. The invoices, however, must be prepared as goods are shipped. They cannot be held until a convenient batch of work has accumulated. What this means from a machine-design point of view is that the clerical machine must be able to take work in random order.

A flow of work in random order requires the use of selective memories. The problem is similar to that of a telephone exchange. Telephone calls are received, by the central exchange, in random order. Selectors must be used to connect with the parties called. Were it not for their relatively low speed, telephone selectors could be used, as is, to solve many selective memory problems that will be encountered in designing machines for business use. The computing machine companies must find a faster and less expensive solution.

Electrostatic memories and acoustic delay lines are fast enough, and selective enough, but far too expensive for all but limited use. Magnetic drums are a step toward lower-cost memories of the selective type. But they too are rather expensive.

Memory Capacity. The contrasts we have already mentioned lead to a fourth, important contrast between mathematical computers and clerical machines. This is the difference in required memory capacity. Low memory capacity has been a limiting factor even in some of the mathematical computers that have been constructed. The problem becomes more acute with business machines.

Hundreds of thousands of stockkeeping units are not unusual in a business concern. A large manufacturer must buy and stock a great number of different parts and materials. A large mail-order house has as many as 300,000 stockkeeping units, counting each color and size advertised in each current catalog as a separate stockkeeping unit. Relatively small department stores have from 20,000 to 60,000 stockkeeping units.

When we come to the names and addresses of suppliers and customers we again run into thousands, if not millions, of separate blocks of information to be referred to. Large companies have from 5,000 to 10,000 suppliers. Popular magazines have several million subscribers, and large distributors have hundreds of thousands of names on their mailing lists.

Since so many separate registers or addresses are required, memories will have to be cheap. Ten cents might be more or less arbitrarily taken as the maximum cost of any one register, including whatever circuits or mechanisms are necessary to locate and read it. A cost of one cent or less would be more nearly ideal.

Fortunately, this severe cost limitation is partly offset by another consideration. Density of reference will be low. During any given period of time, selective reference will be made to relatively few of the total number of memory units. This permits relatively slow reference speeds. Several references can be made simultaneously, to different sections of the memory. By making several references simultaneously, look-ups can be kept ahead of computing speed.

A look-up machine, consisting of banks of reference memories together with appropriate selectors, may very well be entirely separate

from the computer itself. Information may feed from several input machines, to a look-up machine, to a computer, and thence to several output printers. All of the machines would be electrically connected. It should not be necessary to manually carry work, in any form, from one machine to the next.

What Business Needs

Electronic clerical machines of the future can have one tremendous advantage over all of their predecessors. They are inherently capable of doing a whole clerical job, from beginning to end and including any foreseeable variations, exceptions or irregularities that may arise. They are inherently capable of being completely automatic, rather than semiautomatic. The selective-sequence principle of electronic computers, or their ability to solve logical as well as mathematical problems, is the key to their promise in this respect.

The nearest pre-electronic approach to automatic clerical equipment is, of course, punched-card machines. They are widely and economically used. Yet these excellent machines have not completely replaced manual operations on all routine clerical jobs, and there are good reasons why they have not done so. Resistance to punched-card methods does not rest on ungrounded conservatism or blind sales resistance. Punched-card machines can be made to perform virtually any series of clerical operations. But, in some applications it costs as much to do the job by machine as it does to do it manually.

The reasons are three-fold: First, a series of separate mechanical operations is required to produce a single result. Cards must be punched, verified, sorted, collated and tabulated before even the first report is forthcoming. Second, few machines are completely automatic. Cards must often be fed in and manually taken away. In addition, there is a manual card-filing problem. The third and greatest handicap of punched-card machines in some applications is their inability to handle certain irregularities. The machines are ideally suited to large volumes of identical work. But variations usually require either a different series of separate manually-attended operations, or manual prehandling, to get work in such form that it can be fed into the regular flow of work. When we see operators going from one machine to another with little groups of cards, or when we see large clerical staffs getting work ready for the machines, we are often witnessing an application that might just as well be performed manually from beginning to end.

The great promise of electronic equipment lies in its inherent ability to overcome these three limitations. A limited manual input may be required, when documents are not in machine language to begin with. But from then on we are dealing with electrical pulses which travel over wires. We do not have to manually carry data from one operation to the next. The machines can operate unattended. And, since they can compare and select, they can recognize and handle irregularities. Whatever rules can be given to a clerk can be given to an electronic machine.

The heart of the fully automatic clerical machine of the future will be the selective-sequence principle. This principle is used in all of the digital computers that have been built. These computers handle information very much as a clerk does, only faster. All information pertinent to the problem at hand is assembled, including complete instructions as to what to do with each item of information. Each item of information is placed in a definite location on a magnetic drum, in an acoustic delay line or in an electrostatic memory.

Programmed instructions then tell the machine to switch information from one location to another until all desired operations have been performed. Numbers to be added are switched to an adding unit and the sum is switched back to a given memory location. Other arithmetical operations are performed in the same manner. Most important of all, from a clerical point of view, is the fact that different items of information can be compared to determine agreement or non-agreement or to determine the larger or smaller. Depending upon the outcome of a comparison, the machine can switch to one prearranged sequence of subsequent operations or to another. It is in this way that irregularities can be recognized and handled.

All of the circuits that are required to do these things are well proven. Computer men may differ as to the best circuits, but we do have workable circuits. Better input, less expensive random-access memories and faster printers are needed, but we already have in selective-sequence computers what is probably the most difficult component of a completely automatic clerical installation.

The Job Ahead

What remains to be done is to decide what sort of machines to build. What components, of what speeds and capacities, are to be put together to do a given clerical job with maximum economy? Before precisely the right machines can be assembled, the requirements of the job must be understood in detail. This is an undertaking for industrial engineers.

All or most clerical work may follow the same general pattern. But similarity ends when we go beyond generalities. No two clerical jobs are identical. Common parts and common sub-assemblies will no doubt be used in all electronic clerical machines, but to do the whole job each machine will almost certainly be modified to suit individual performance specifications.

The industrial engineering that remains to be done is thus twofold. First, enough must be known about clerical work of all types to design the best possible common components. Second, each application must be analyzed in detail before the machine for that application is finally put together.

The desirability of an ideal machine for each clerical job can, perhaps, be overemphasized. Less-than-ideal machines can be sold. But anyone who has experienced the compromises and the borderline decisions that often have to be made in using present-day office equipment cannot help dreaming of a machine that is engineered for their particular work.

Such machines would sell themselves.

The Vidicon

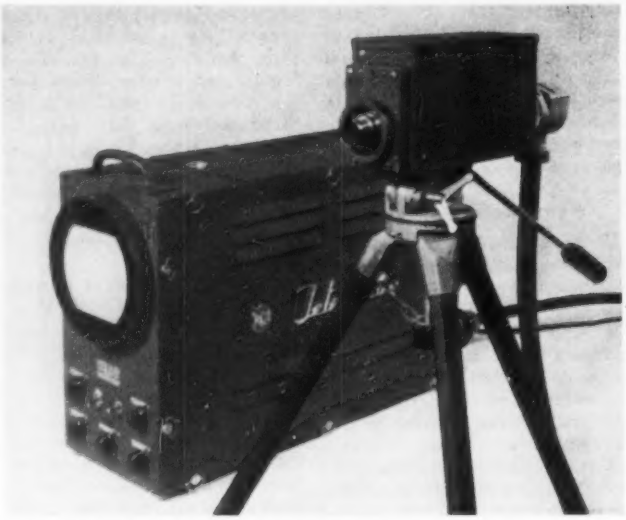
THE PHENOMENON of photoemission of electrons has been widely used for the light-sensitive surface of television pickup tubes. This is true for the image orthicon[1] as well as for its predecessors, the orthicon and the iconoscope.

The related phenomenon of photoconductivity has not been employed in any commercially useful pickup tube. However, this application of photoconductivity has by no means been ignored either in the experimental laboratories or in the patent literature. In fact, one of the earliest proposals for a television system envisioned the use of a selenium photoconductive cell in combination with a mechanical scanning disc. Actually, the sluggish frequency response of the selenium cells made them inadequate for this application. Photoemissive cells which became available in the early part of this century were found to be much more suitable.

During the middle 1930's, work on photoconductive targets for television pickup tubes was carried on in this country[2], as well as in England[3] and Germany.[4] In these experiments an electron beam similar to that used in the iconoscope scanned the photoconductive target. This mode of operation allowed the possibility of obtaining increased sensitivity by means of storage. Furthermore, the photoconductor needed to respond to changes in light intensity no faster than thirty cycles per second as compared to the several million per second that is required for nonstorage operation.

None of these experiments resulted in a useful tube able to compete with the iconoscope available at that time. The principal defects were insensitivity, retention of images and spurious spots on the target. Once again photoconductivity for pickup tubes was set aside at least temporarily in favor of photoemission whose processing art was somewhat more advanced.

Work done during the war on photoconductive materials for infrared detectors has served to focus attention on the basic advantages which photoconductivity has to offer to television pickup tubes. It is well known that the light sensitivity obtainable with photoconductive cells greatly exceeds that reported for any photoemissive cells. Whereas a sensitivity of 50 microamperes per lumen (about 0.10 electron per quanta) is considered good for photoemission, tens of thousands of microamperes per lumen (many electrons per quanta) are not uncommon with some photoconductive materials. (An image orthicon employing a photocathode giving 50 microamperes per lumen has an operating sensitivity comparable to



Miniature television camera employing the vidicon pickup tube*, with standard image-orthicon camera in background

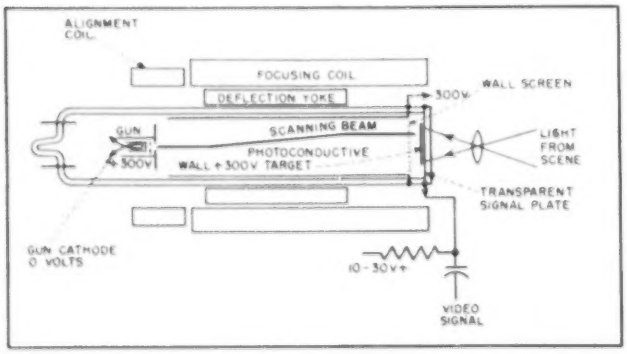
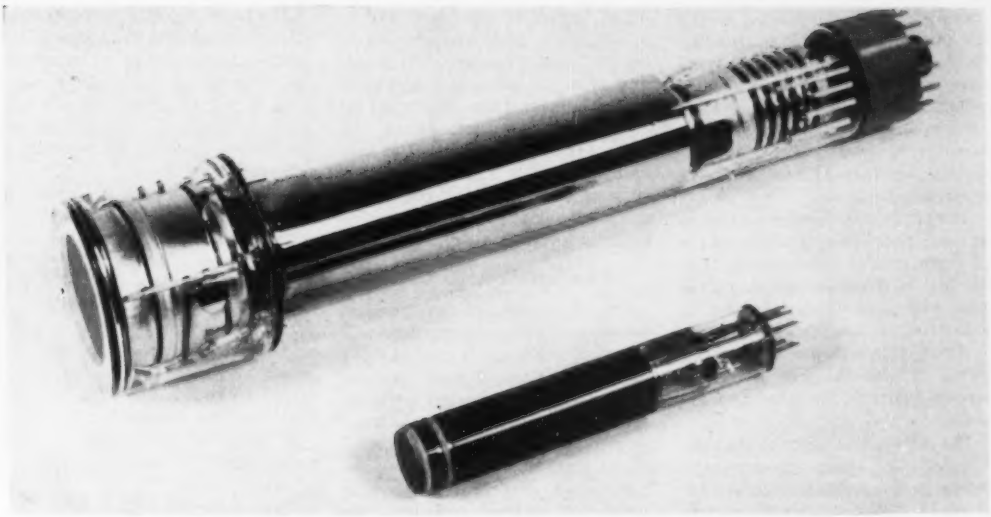


FIG. 1—Cross-sectional diagram of an experimental vidicon photoconductive television pickup tube

* Presented at IRE National Convention, New York, March 1950.



Experimental one-inch-diameter vidicon, with the standard commercial image orthicon in the background

Photoconductive Camera Tube

Simplification of design, high sensitivity and good resolution are available in a new tube having a photoconductive target. Its application results in economy of equipment designed for unattended industrial applications as well as broadcast use

By PAUL K. WEIMER, STANLEY V. FORGUE and ROBERT R. GOODRICH

RCA Laboratories
Princeton, New Jersey

that of the human eye.[1]

If high-sensitivity materials suitable for pickup tube targets could be found, the benefits could be used in two ways. Perhaps least important at present would be the possibility of developing tubes capable of operating at much lower light levels. An improvement of about 10 times over that of the present day image orthicon[2] is theoretically possible, assuming that on the average, the best photoemitting surfaces are only 10 percent efficient. Second and more important, any sizeable increase in target sensitivity would permit such simplification in pickup tube design as to open up entirely new fields of application. The electron image section and the electron multiplier, which have been required in the image orthicon for good sensitivity, may be entirely eliminated. The tube is reduced to the basic elements of gun and target. This makes for economy, compactness and simplicity of operation.

In addition, all the tube dimensions may be scaled down, if desired, because the extra target sensitivity is available to compensate for the reduction in target area. It was easily conceivable that a simple, compact and dependable television pickup tube would find many applications in industry, business and in scientific investigations far wider than that of entertainment broadcasting.

Work on photoconductive pickup tubes has been carried on inten-

sively at RCA Laboratories during the past several years. High-sensitivity materials suitable for targets have been found and many experimental photoconductive tubes of various sizes have been tested. The name "vidicon" has been coined to distinguish these tubes from the photoemissive tubes.

The particular form of vidicon to be described is in an advanced stage of experimental development. It is one inch in diameter and six inches long, and is particularly suited to industrial applications. It appears likely that both larger and smaller forms of vidicons will eventually become available for other applications.

The comparative sizes of the vidicon and the image orthicon are shown in an accompanying photograph. A miniature television camera employing the vidicon is also illustrated.

One-Inch Vidicon

The cross-sectional diagram of an experimental tube given in Fig. 1 shows the relative positions of the gun and the target.

As shown in Fig. 2, the photoconductive material is deposited on the transparent conducting signal plate and scanned directly by the electron beam. A uniform magnetic field is used to focus the beam. The velocity of impact of the beam may be either below first crossover as in the orthicon, or above first crossover as in the iconoscope. The video signal is taken from the target by connecting the amplifier to the transparent signal plate. The wall screen shown in Fig. 1 provides a uniform field in front of the target, but does not appear in the transmitted picture.

Charge-Discharge Cycle

For purposes of explanation, assume that a low-velocity orthicon-type scanning beam is used. A fixed potential of about 20 volts positive, relative to the thermionic cathode, is applied to the transparent signal plate. The beam deposits electrons on the scanned surface of the photoconductor charging it down to thermionic cathode potential. Although considerable field is thereby developed across the opposite faces of the photoconductor, its conductivity is sufficiently low that very little current flows in the dark.

If a light image is focused on the target, its conductivity is increased in the illuminated portions, thus permitting charge to flow. In these areas the scanned surface gradually becomes charged a volt or two positive with respect to the cathode during the 1/30-second interval between successive scans.

The beam deposits sufficient electrons to neutralize the accumulated charge, and in doing so generates the video signal in the signal plate lead. It will be noted that the target is sensitive to light throughout the entire frame time permitting full storage of charge.

The charge-discharge cycle is identical to that of the orthicon with the exception that the positive charging effect is achieved by photoconduction through the target itself, rather than by photoemission from the scanned surface. This mode of operation requires that the resistivity of the photoconductive target be sufficiently high that its time constant exceeds the 1/30-second television frame time. A dark resistivity of 10^{12} ohm-cm or greater is satisfactory.

Many materials such as selenium, sulfur, as well as the sulfides, selenides and oxides are known to be photoconducting. Several of these materials when properly processed have been found suitable for pickup tube targets. The spectral response is a function of the material and the processing. Targets which are sensitive to the entire visible range of the spectrum have been made.

Operating Characteristics

Photoconductive targets free from the spurious spots and lag which troubled the earlier workers, have been made. Sensitivities in excess of 1,000 microamperes per lumen are obtainable. Resolution is limited only by the electron optics of the beam while in the image orthicon a fine mesh screen at the target limits resolution.

The one-inch diameter vidicon is capable of resolving more than 600 lines. Under similar conditions the larger image orthicon will give about fifteen hundred lines. The capacity of the target may be made sufficiently large in any size target that the high light signal-to-noise ratio of the output signal can be as high as needed.

The signal-vs-light curve is linear at low lights as in an orthicon, but with some flattening off at high light levels. In general, the photoconductive targets made to date will not accommodate as wide a range of light levels for a given

Photograph of picture transmitted by a one-inch vidicon

lens aperture as an image orthicon. For extremely bright illumination on the target, the picture loses contrast without any tendency for unstable charge up as in the early orthicon. An image orthicon under similar conditions would maintain good contrast by virtue of the redistribution of secondary electrons on the picture side of the glass target.

In general, pickup tubes with photoconductive targets are simpler in operating adjustments than an image orthicon. The electron image focusing control is completely eliminated, and the target voltage adjustment is somewhat less critical.

The high signal level obtainable at the target removes the need for an electron multiplier whose contribution to spurious spots and shading in the image orthicon has been a steady source of concern. The beam-current adjustment is accordingly less critical. In short, the simplicity of operation of the photoconductive targets combined with their adaptability for small tubes has made them particularly suitable for equipment designed for unattended industrial applications.

Sufficient satisfactory tubes have been constructed in the laboratoory to demonstrate the advantages listed above. However, questions of tube life, allowable temperature limits and reproducibility of results will require additional intensive development before equipment reliable enough for industrial use can be made available. For example, conditions necessary to ensure targets free of objectionable time lag are still in an experimental stage.

Sensitivity of the Tube

A one-inch vidicon possessing a target sensitivity of 300 μa per lumen will transmit a noise-free picture with a scene brightness of several foot-lamberts using an f/2 lens. Since this light level is less than ordinarily present in most laboratories or factories, special lighting is not required.

It is impossible to compare the relative sensitivities of the vidicon and the image orthicon without specifying at what light level the comparison is being made. At intermediate light levels, with a few foot-lamberts scene brightness, the two tubes will transmit a picture having about the same signal-to-noise ratio. At higher light levels, the vidicon will deliver a higher signal-to-noise ratio than the image orthicon since its target capacity is higher. At lower light levels its signal-to-noise ratio will be inferior to that of an image orthicon with a multiplier.

This follows from the fact that the noise background for the vidicon is the amplifier noise that remains fixed at all light levels, while for the image orthicon it is shot noise in the scanning beam, which may be reduced somewhat for low signal levels. With the development of still more sensitive targets, the vidicon without a multiplier may be expected to exceed the present image orthicon at all light levels.

It will be noted that the elimination of the electron multiplier will require a stronger beam current at the target of the vidicon than in the image orthicon. Assuming the input noise of the video amplifier to be 2×10^{-8} microampere, a target current of 0.2 microampere is required for a signal-to-noise ratio of 100. This current is about ten times that required in the image orthicon.

Some explanation as to why a smaller pickup tube may require a more sensitive target for equal scene brightnesses is in order. If the entire tube and optical system are scaled down in size, keeping the same f number lens, the quantity of light in lumens intercepted by the lens is reduced. The output signal of the tube in microamperes is also reduced unless the target sensitivity in microamperes per lumen is increased.

On the other hand, if the lens diameter for the small tube were kept the same as for the large tube, no increase in target sensitivity is necessary. However, for the same angle of view this means a faster or lower f number lens. Such lenses, if available at all, are likely to be less highly corrected and more expensive. Thus, in general, the smaller tube will be operated with smaller diameter lenses requiring higher scene brightnesses or more sensitive targets. The gain in depth of focus accompanying the use of the smaller diameter lens may, however, be very useful. Motion picture 16-mm lenses have been found to be satisfactory.

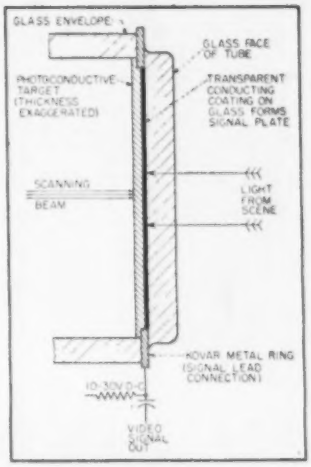


FIG. 2—Detail of the target construction in the experimental photoconductive camera tube

The writers wish to thank V. K. Zworykin and Albert Rose for their continued interest and advice during the course of this work. The construction and testing of tubes has been greatly aided by the cooperation and assistance of A. D. Cope and P. G. Herkart. We are indebted to S. M. Thomsen for preparation of photoconductive materials. The development of miniature camera equipment by R. C. Webb and J. M. Morgan has facilitated the evaluation of tube performance.

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Automatic Exposure

Aerial photography above 600 mph under varying lighting conditions normally demands a compromise in camera settings. A new photoelectric servo control of aperture providing optimum exposure is applicable to motion-picture and television cameras

By GEORGE BRUCK, JOHN HIGGINS and JOHN WARD

Specialties, Inc.
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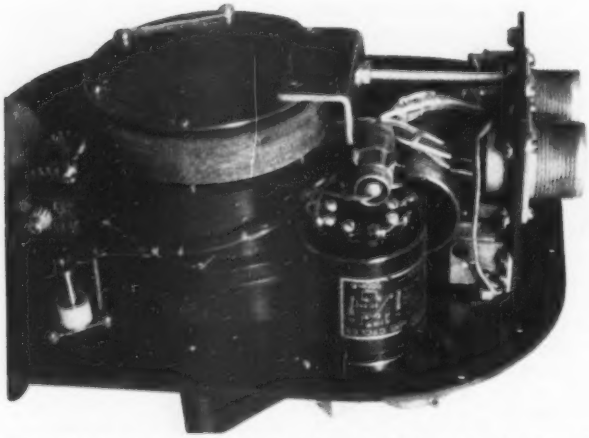
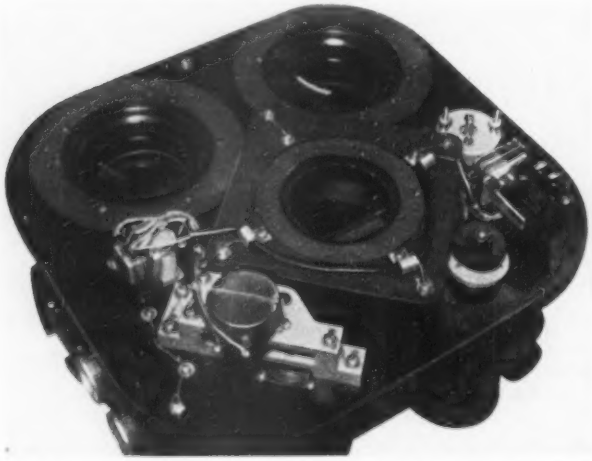


Underside of aperture control showing photocell and heater housing (center) and servo motor (lower right)



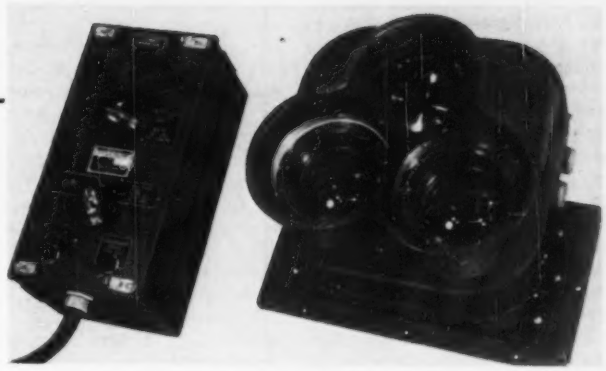
Lens assembly with cover removed showing camera irises to rear, photocell iris and derivative potentiometer

LOW-ALTITUDE reconnaissance photography at speeds in excess of 600 mph requires rapid automatic adjustment to changing light values. The requirements for good color photography (as illustrated by the front cover of this issue of ELECTRONICS) are even more stringent. Compromises in conventional photography are apparent when the average newsreel is compared with the average studio production. In color work, even the quality of the latter is sacrificed by compromise settings for sequences. In solving the two-fold problem of automatic light control and automatic shutter-speed control, the former has been attacked first by providing a servo system for varying the iris aperture.

The camera so modified is a U. S. Air Force Model S-7 equipped with stereoscopic lenses and an open, slit-type shutter. Film is exposed by being driven past the slit as a function of ground speed and as an inverse function of altitude. This combination synchronizes the moving image on the film. Film exposure time is expressed in equivalent shutter speed; for example, an equivalent shutter speed of 1 25th of a second indicates that the slit width is adjusted, as a function of film speed, so that the passing film receives an exposure equal to that obtained by stationary film behind a conventional shutter operated at 1 25th of a second.

The stereo lens assembly is modified to include an additional lens with variable aperture, a photocell, a photocell heater and thermostat

Control



Assembled lens turret beside control box that contains all the electron tubes

and a motor with the necessary gearing for driving all three apertures. An armored cable connects the lens assembly to an operator's control box containing an amplifier, operating switches, an operating indicator and a warm-up indicator.

Manual selection is provided to preset the control for use with films having ASA exposure indexes of 12, 25, 35, 50 and 100. A separate control is provided to match equivalent shutter speed settings of 1/50th, 1/100th, 1/200th and 1/400th of a second on the camera. Depending on the type of film and the equivalent shutter speed, the control regulates aperture size to permit constant light intensity at the film, even though the maximum illumination encountered may be 40 times greater than the minimum. An indicator shows the operator whether or not light conditions are beyond the scope of his shutter setting and tells him which way to adjust it when required. With these manual adjustments, the control can accept a maximum-to-minimum light ratio of 325 to 1.

How It Works

The basic system is shown in the block diagram of Fig. 1. Assuming normal operation, any change of light intensity reflected from the terrain will change the output of the photocell. A resultant unbalance at the comparator produces an output that is filtered, phase-shifted, and amplified to drive a servo motor geared to the camera apertures. As soon as the apertures reach a position establishing correct light intensity at the photocell (and film) the system corrects itself for balance. A derivative of aperture change is applied to the comparator for antihunt purposes.

Camera equivalent shutter speeds are matched by means of a selector switch that inserts one of several resistors in the reference circuit. The ASA film exposure indexes are matched by means of a selector knob that places one of several calibrated light baffles in front of the photocell. To protect the photocell from stray light when the camera is not in operation, a shutter covers the photocell aperture. A solenoid opens the shutter whenever power is applied to the equipment.

The sensing unit is designed in the form of a barrel, somewhat resembling a small camera as shown in Fig. 2. Mounted at the forward end of the barrel is a Fresnel lens of transparent plastic, which entails less bulk and expense than an equivalent lens of glass and allows the use of a large opening. Very thin, and very finely grooved, the Fresnel lens gives sufficient definition of the image for proper control of the viewing angle.

The barrel aperture is directly geared to the main lens apertures. Perfect proportionality between the photocell and main lens apertures can not be assumed, however. For the larger openings (up to f:1) used at the photocell aperture, the vignetting effect becomes increasingly important so that the actual optical opening deviates from the calculated opening by a considerable factor. Correction is made by inserting a piece of star-shaped, opaque, metal foil behind the Fresnel lens.

The image is formed at a rectangular opening that divides the forward and rear sections of the barrel, and is then diffused in the curved, highly polished rear section enclosing the photocell. This even illumination of the cell prolongs its life, improves its absolute accuracy, and represents almost exactly the average light intensity at the actual film.

While it might seem that a standard vacuum or gas phototube

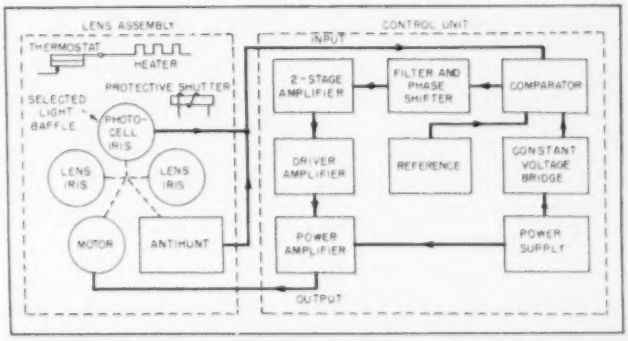


FIG. 1—Elements of the automatic iris aperture control system

would provide satisfactory information, investigation shows them to have a poor absolute accuracy in comparison with the selenium photocell.[3] The only photosensitive element presently known to have a fairly good absolute accuracy is the barrier-layer type selenium photocell. The voltage obtained from this type of cell, however, is extremely low at the light levels encountered, and not suited for direct amplification. Considerable difficulty was encountered in attempts to use a 400-cycle electromechanical chopper to transform the available d-c signal into an a-c signal suitable for further amplification. It therefore seemed desirable to use other methods.

Selenium-type photocells have the property of conducting in one direction if they are not illuminated. Illumination creates some reverse conduction, and with constant voltage applied, the reverse current is essentially proportional to the intensity of illumination. This property is used to advantage here.

It is necessary to obtain constant voltage with a bridge consisting of precision resistors and a tungsten-filament lamp shown in Fig. 3. The lamp filament changes resistance with changes in the 400-cycle supply voltage and unbalances the bridge in the direction necessary to maintain the desired output. Constant applied voltage is requisite for maintaining absolute accuracy of the photocell, and the bridge provides a voltage output constant within a few percent.

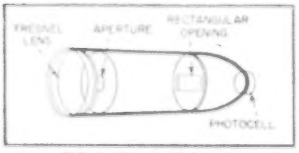


FIG. 2—Photocell barrel

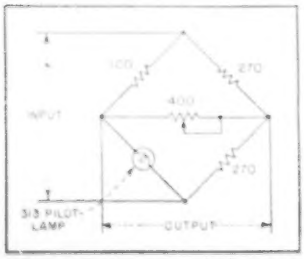


FIG. 3—Constant voltage bridge circuit

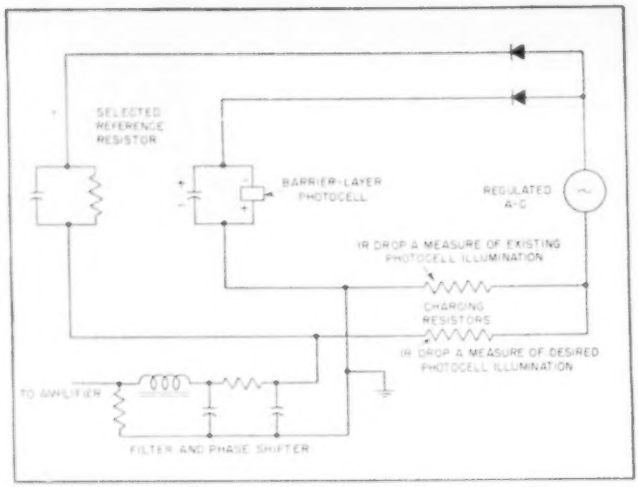


FIG. 4—Comparator unit showing output filter and phase shifter

The constant a-c voltage is applied through a rectifier, building up a constant d-c voltage across the capacitor and photocell represented by the inner circuit of Fig. 4. Current passed by the photocell is approximately proportional to light intensity and it discharges the parallel capacitor at a rate proportional to this illumination. Through the rectifier, the capacitor is recharged once every 2.5 milliseconds to the peak value of the regulated a-c source. The flow of this charging current through a series resistor produces a voltage drop that is the measure of existing photocell illumination.

A reference circuit is connected in parallel with the photocell circuit as shown, duplicating the latter except for a fixed resistor in place of the photocell. The value of the resistor is selected according to equivalent shutter speed in use. The flow of charging current through the series resistor of this circuit produces a voltage drop that is the standard for desired photocell illumination. Voltage drops across the charging resistors of the two circuits are compared in phase opposition. When the voltage drop owing to existing photocell illumination equals the standard for desired photocell illumination, the comparator output becomes zero, indicating that the photocell aperture is the correct size. Since the photocell aperture is geared to the lens apertures, this also indicates that light intensity at the film is correct. When existing illumination needs correction, one voltage predominates, resulting in a comparator output signal of particular magnitude and polarity.

High harmonics in the pulse-type signal from the comparator are eliminated in a filter that also rotates the phase angle ninety degrees. The filter unit consisting of one pi-section with load resistance, supplies an approximate sine-wave voltage to the grid of the first amplifier tube.

Amplifier Design

Servo applications require a limiting amplifier that gives increasing output for increasing error up to a predetermined design point. Beyond this point, an output proportional to error would demand excessively ponderous servomechanisms if, indeed, any mechanisms capable of sensitive control could stand an output proportional to maximum error.

Speed limitations and torque limitations of the aperture drive dictate the size of the motor. This parameter is a measure of the size

of the output tube and of output power. To obtain speed and accuracy, full output power must be reached with little error input, requiring high voltage amplification with powerful limiting action. These characteristics are indicated in the operational curve of Fig. 5.

One disadvantage of a conventional vacuum-tube amplifier is the limitation imposed on the input signal to avoid blocking. A powerful input signal, when peak rectified, builds up a negative bias at the grids of the voltage amplifiers. When stored in the coupling capacitors, this bias takes an appreciable time to dissipate and effectively blocks a subsequent weak signal,

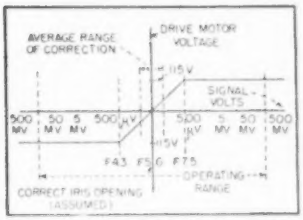


FIG. 5—Characteristic of the aperture control

which, as a result, is not properly amplified. To maintain quick recovery with this type of amplification, the range of signal input is normally restricted.

Restriction of signal input is avoided in the aperture control amplifier by using a Thyrite resistor in the grid circuits of both the second and third stages. This element eliminates blocking and gives the amplifier an extremely rapid recovery time (15 milliseconds for a 60-decibel input overload) as well as a nonlinear gain characteristic. The amplifier has a gain varying so rapidly with the incoming signal that the servo system cannot be considered linear, except immediately adjacent to the null point.

As shown in Fig. 6, the signal is first amplified in one-half a high-mu triode, then amplified a second time in the other half of the tube. The properties of the Thyrite resistor, attached to the grid of the second stage, are such that its resistance decreases as applied voltage increases. Therefore, any powerful signal applied momentarily to this grid is almost immediately dissipated through the resistor, clearing the grid of bias effect.

A Thyrite resistor is also used in the grid circuit of the driver stage further to reduce recovery time and prevent blocking. As the signal input increases from zero to 0.5 millivolt, driver output increases in a ratio that is practically proportional. Above 0.5 millivolt, the output remains constant at full power. One-half a 12AT7 tube serves for the driver, and is transformer-coupled to the last, or output stage of the amplifier.

The output stage shown in Fig. 7 uses a type 5687 double triode operated in Class B. Under normal conditions, this tube could not continuously supply the 12 volt-amperes required for the variable phase of the two-phase servo motor. Because of the intermittency of the service, however, it is possible to use the tube without exceeding its long-time plate dissipation rating. In fact, the tube is used considerably below its maximum dissipation ratings.

Maximum power is obtained by supplying the 5687 grids with a fixed bias of −20 volts. The voltage is obtained from the power transformer through a germanium diode rectifier of the high-back-voltage type and a small, pi-section, inductance-capacitance filter.

Antihunt Circuit

It is generally considered advisable to damp linear servomechanisms with the derivative of the error signal. This practice is not necessarily correct for the nonlinear type dealt with here. In this case, a velocity or viscous damping so calculated that it would represent considerable over-damping for a corresponding linear servo proves more favorable.

The damping signal is the derivative of a voltage proportional to the effective optical aperture and

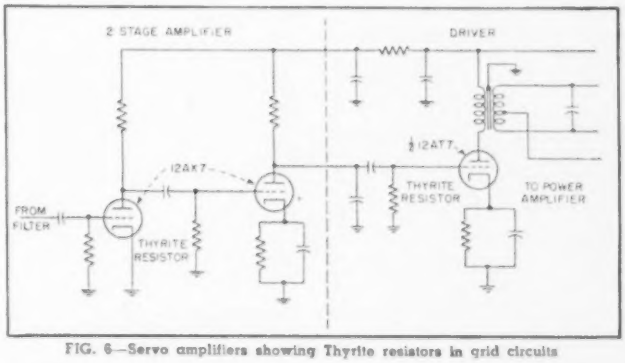


FIG. 6—Servo amplifiers showing Thyrite resistors in grid circuits

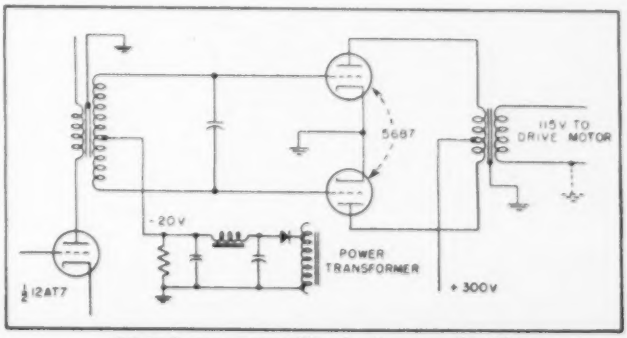


FIG. 7—Servo power amplifier showing source of grid bias

includes the mechanical inertia of the servo system. Therefore, this signal has a maximum value corresponding to the maximum rate of change of the effective lens area. It never needs to be more, regardless of the amount of error. The derivative is added to the input signal, but since the equipment is working on a nonlinear portion of the gain characteristic, the damping factor has no effect until the null point is practically reached. Then, as a large amount of retarding force, it comes into full effect and halts the mechanism abruptly.

The aperture drive is mechanically linked to a variable resistor so that voltage drop across the resistor changes as a function of the aperture opening as shown in Fig. 8. This function has been so determined that the rate of change of voltage is correlated with the rate of change of the lens opening to assure proper damping over the full range of aperture openings from f:2.5 to f:16. The function is highly nonlinear, being approximated by a section of a parabola. To obtain accurate results, it is imperative to make the current through the variable resistance independent of current and voltage variations in the rest of the circuits.

The desired derivative voltage is relatively small and power-supply ripple voltage may easily override it. To avoid this difficulty, a special regulator has been provided that holds the voltage supply to the derivative circuit constant. This regulator comprises a neon tube and the unused half of the driver tube.

The current, through the resistor, used to obtain the rate of change of the aperture is a measure of the actual location of the aperture. The current passes through an offset-zero milliameter located on the control box panel and calibrated in f-stops. It is used as a fairly accurate indication of aperture position and warns of extreme light levels, so that the operator can change equivalent shutter speed before making a series of shots.

Shown in Fig. 9 are the voltage wave shapes observed at various stages of amplification. The ratio of output to input power is approximately 1.5×10^{n}, or about 140 decibels. While this is not an exceptionally high ratio for an audio amplifier, it is extreme for a servo amplifier and would ordinarily lead to objectionable hunting. This effect is avoided by the nonlinear gain and antihunt circuits.

Its sensitivity combined with the nonlinearity makes the aperture control applicable to a wide range of photographic lighting conditions. A white sand beach in midsummer will seldom reflect more than 10,000 foot-candles illumination, while a dark pine forest, on an overcast day, may reflect as little as 10 foot candles. Using a color film of slowspeed (ASA index 35) and equivalent shutter speed as dictated by conditions, the aperture control corrects for illuminations between 32 foot candles and 10,000 foot candles. With a black-and-white film of fairly fast speed (ASA index 100) and equivalent shutter speed as dictated by conditions, the aperture control corrects for illuminations between 16 and 20,000 foot-candles.

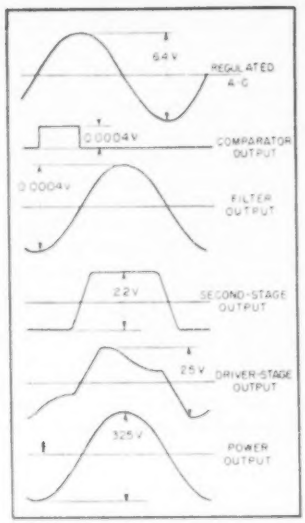


FIG. 9—Voltage wave shapes under conditions of large error (f:0.5 stop)

Further development of the same basic control system demonstrates that the range of aperture correction can be extended to include illumination as low as 1.5 foot-candles. Extension of the range for higher illumination is also possible, but hardly necessary, since no climatic or topographical conditions reflect light above the present maximum. Should a different application require further extension of range upward or downward, the control could be suitably modified.

The authors wish to express thanks for cooperation received from personnel of the Aerial Camera Branch of the Photo Laboratory at Wright-Patterson Air Force Base, under Colonel George W. Goddard, Chief, who inspired development of the equipment. Appreciation is especially due to Major Arthur E. Smith, USAF, and Robert Roalef.

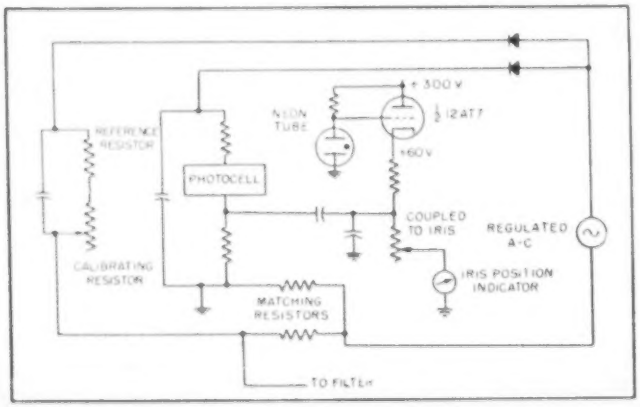


FIG. 8—Method of coupling antihunt derivative circuit into input

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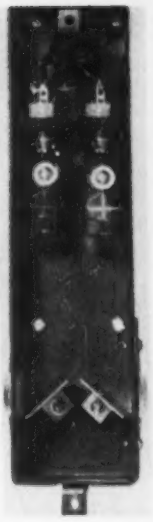
Bowling-Alley Foul Detectors



By ERNEST JELLINEK

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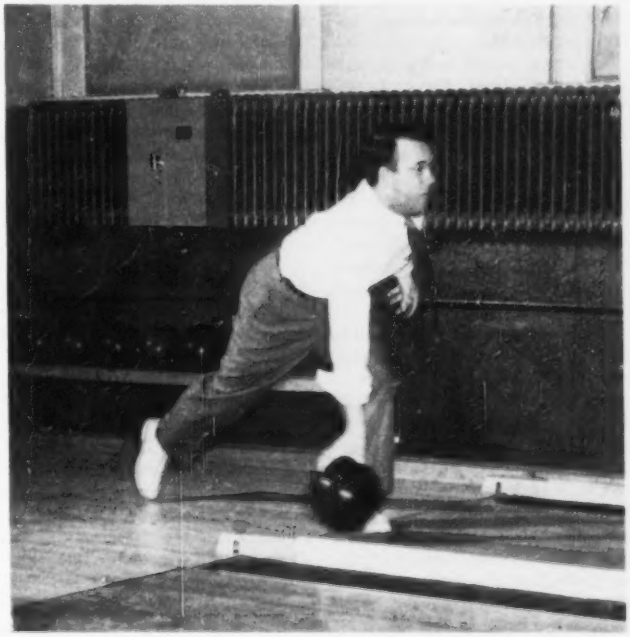
Continual development work on foul detectors and certain revisions of American Bowling Congress rules permit use of photoelectric devices for detecting sliding fouls in league competition. Design considerations and circuit details are explained

PHOTOELECTRIC foul detectors have been known for a good many years, but until recently, certain limitations prohibited their use during league competition. The rules set forth by the American Bowling Congress did not lend themselves to foul-line detection by electronics.

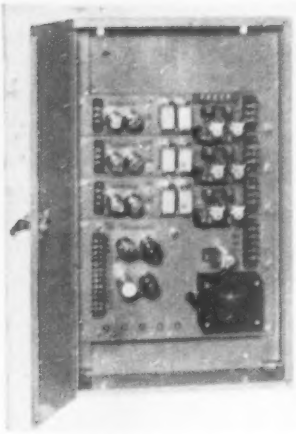
It was noted that over ninety percent of all fouls were of the sliding-foot type, and that fouls of this type were most difficult for judges watching several alleys to detect. The critical line was an infinitesimally narrow one at the front edge of the foul strip. The Congress has since modified its rules and widened the critical line to one-quarter inch. This provides sufficient latitude for the design of practical photoelectric foul detectors, and other types of fouls are readily detected by other players.

Typical Installation

A typical sliding foul detector installation consists of a light source, which projects a narrow light beam along the foul line close to the floor,



Light source and phototube units, shown in detail at the top of the page, are mounted behind rectangular apertures in division boards between alleys



Each panel in the control unit serves two alleys

and a phototube unit at the other side of the alley to receive the beam. A control panel provides voltage for the light source units and receives current from the phototube units. Its function is to operate the proper foul light and a bell when a foul occurs on any alley. Foul lights are located above the pins at each alley, and a common foul bell is energized when a foul occurs on any alley.

The light source and phototube units are designed for mounting at the foul line in place of the division board, or inside the ball return separating two alleys. Each light source is capable of projecting a beam of light in two directions and thus can be used to cover either a single alley or two adjacent alleys. Each phototube holder is similarly designed to cover either a single alley or two adjacent alleys.

For uniform light distribution to the required height a rectangular, rather than a round, beam shape is used. It is ¾ inch wide and 1¼ inch high, starting ¼ inch above the floor.

To obtain good formation of the light beam, a long-focal-length lens system is used. This system is designed so that the projected image of the lamp filament focused on the lens of the receiving unit across the alley is approximately the same width as the lens. In this way, the beam is the same width from one side of the alley to the other. The long-focus system also prevents unwanted light from being received by the phototube.

A three-inch focal-length lens magnifies the image of the ⅝-inch lamp filament to about ¾ inch at the standard alley width of 60 inches. To fit this system into the available narrow width of a division board the focal length is folded at right angles to the foul line by two mirrors. Each mirror reflects light toward the phototube holder on one side. Focusing is accomplished by sliding the lamp bracket. Aiming of the beam is done horizontally by rotating the mirror, and vertically by bending it slightly.

The phototube unit contains two type CE22 end-on phototubes. One or two phototubes may be used in each holder, depending upon whether one or two alleys are being covered.

Foul-Light Circuits

The foul-light relay circuit for any alley must keep the foul light off when the light beam is unbroken. It should not respond to light interruptions lasting less than 0.1 second, to allow the ball to pass through the beam without a foul being indicated, and it must respond to light interruptions longer than 0.1 second, which may be considered due to a foul. It should then light the foul light, transmit a pulse to the foul-bell relay circuit, discontinue being responsive to the light beam if the beam is re-established, it must be ignored until the end of the timing cycle), and it must keep the foul light lit for a fixed period of from ten to fifteen seconds, then reset, and be ready to indicate another foul or continued interruption of the light beam.

The circuit shown in the simplified diagram utilizes only one relay for each alley. The relay is connected so that after responding to a beam interruption it disconnects itself from the phototube amplifier circuit and becomes a timing relay. After completion of the timing cycle, during which it energized the foul light, it resets to its original condition.

The high-impedance phototube circuit is in the grid circuit of a cathode follower which drives the grid of the relay power amplifier. Switching takes place in the lower-impedance circuit between the cathode follower and the power amplifier.

As shown in the diagram, the cathode of V_{1A} is connected through the normally closed contact of RE_1 to its load resistor R_k. This is connected to a bus that is fifty volts negative with respect to the cathode of V_{2A}, which is at ground potential. The cathode potential of V_{1A} follows the grid potential but is about three volts more positive.

The cathode of V_{1A} is connected to the grid of V_{2A} through R_p. The grid of V_{1A} follows the variations of phototube signal voltage and controls the current through RE_1 accordingly. Normally, with light on the phototube, the grid of V_{1A} is drawn negative by phototube current flowing through R_p. No plate current flows, and RE_1 is deenergized. Interrupting the light beam decreases the phototube current and the grids of both tubes become more positive. After a small time delay, due to capacitor C_1, RE_1 becomes energized and a foul is indicated for that alley.

Time-Delay Circuit

The time delay provided by C_1 prevents a foul from being indicated when a ball rolls through the light beam at normal speed.

Capacitor C_1 introduces a capacitance-coupled negative feedback which amplifies the actual RC time constant by approximately the gain of the stage. This occurs because any change of plate voltage will be coupled back to the grid in opposition to the grid change which caused it, thus slowing down any further change. When there is no change of plate current, as when the tube is below cutoff or above saturation, there is no amplification of the time constant.

As explained previously, with the light beam unbroken the grid of V_{1A} is negative with respect to its cathode and the tube is cut off. How far it is negative depends upon the light intensity and the phototube sensitivity at that alley; this may be anywhere from 7 to 25 volts. When the grid potential rises due to interruption of the beam, the time constant does not become really effective until cutoff is

reached. Thus, the time delay is quite consistent for each alley regardless of light intensity or phototube sensitivity. Consequently, no field adjustment is required at the time of installation, nor will readjustment be required as the lamp and phototube age. This would not be true if the delay were obtained with a capacitor across the phototube load resistor R_3, as the charge on the capacitor would be different for each alley.

Disabling Circuit

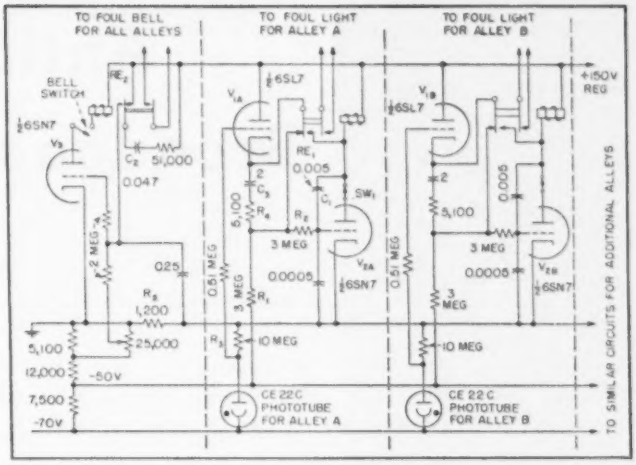
When the foul-light relay becomes energized it turns on the foul light over the corresponding alley and opens the circuit between the cathode follower and the power amplifier, making it no longer responsive to the light beam. It also connects uncharged capacitor C_3 to the plate of V_{2A}. The junction of R_1 and R_4 thus suddenly rises to about 100 volts, causing V_{2A} to suddenly conduct fully. As C_3 charges, this potential comes down towards its ultimate potential of minus 50 volts. This causes a corresponding decrease in plate current of V_{2A}. The Miller effect is used to increase the time delay obtainable with small components. In about 13 seconds the grid of V_{2A} reaches a potential of minus 6 volts and RE_1 becomes deenergized.

This turns the foul light off and recloses the normally closed contact in the cathode-follower circuit. The circuit is thus reset, as the power amplifier is again responsive to the light beam. Also, the timing capacitor C_3 is discharged through resistor R_4 and is ready for another timing cycle. If the light beam is still interrupted, the relay will become energized again and the cycle will repeat. If desired, switch SW, may be opened to prevent a foul indication.

Foul-Bell Operation

When a foul is detected, the foul bell must ring for one or two seconds while the foul-light relay remains on for about 13 seconds. The bell circuit must be able to respond to another foul, even though one or more foul-light relays are energized.

To meet these requirements, a circuit was devised to utilize the pulse derived from the sudden increase of current drawn from the power supply when any foul-light relay becomes energized.



A common bell serves all alleys and rings for a few seconds when a sliding foul occurs. Visual indicators on each alley remain lit for about 15 seconds

The current from all foul-light relays flows through a common resistor R_5 in the cathode circuit on the power panel. If any relay picks up, the voltage across this resistor will increase suddenly. The voltage is capacitively coupled to the grid of V_3, the foul-bell relay tube. The positive pulse derived causes RE_2 to become energized, turning on the bell. In a timing circuit similar to that of the foul-light relay, RE_2 connects the grid to C_2. This causes the relay to remain energized until the capacitor charges, bringing the grid potential down. When the relay becomes deenergized, C_2 is discharged by the normally closed contact of the relay, and is ready for another operation in response to a further sudden increase of voltage across R_5.

It was noted previously that when the foul-light relay became energized, its current suddenly increased from the value at pickup to the saturation current of the tube. This is the result of RE_1 drawing the grid of V_{2A} positive when it picked up. Even if the light beam is interrupted very slowly, in such a manner that the current increases from zero to the pickup value very slowly, an abrupt increase of at least 5 milliamperes is obtained.

Control and Power

The control unit contains the power supply and the bell-relay circuits for any number of alleys up to sixteen. To this are added from one to eight relay panels to cover the number of alleys at the particular installation up to sixteen. Each relay panel section contains the foul-light relay circuits for two alleys.

It is interesting to note that the design of the d-c plate supply is based on the laws of probability. In an establishment where sixteen alleys are in use simultaneously, the occurrence of ten fouls in a five-hour evening is considered rare. The probability of two of them occurring during the same fifteen second interval is accordingly somewhat remote. The probability that three fouls will occur during the same fifteen-second interval is extremely remote. Therefore, it is safe to design the equipment to indicate a maximum of four simultaneous fouls.

The d-c power supply, instead of being large enough to energize sixteen foul-light relays at once, need deliver only enough power to energize four, which also reduces the problem of regulation of the power supply.

Radio Frankfort loop-fed antenna under construction

Antifading Broadcast Antenna

The service area of a broadcast transmitter within which interference between ground and sky-wave components does not occur can be extended by reduction of high-angle radiation from the antenna. Use of a sectional mast with an insulator cancels the progressive wave usually found on fabricated towers

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THE RECEPTION of a broadcast station in the frequency range 0.5 to 1.6 mc is frequently affected by fading at relatively short distances, especially at night. This kind of fading, which results from interference of ground and sky wave, is observed at distances of about 50 to 100 miles or more. It causes linear and nonlinear distortion at the receiver, sometimes to an extent which completely spoils a high-quality radio program, even with avc in the receiver. This effect is true also for a high-power station, the signal from which is strong enough to overcome r-f noise. As a result, a considerable part of the potential coverage area of many radio stations suffers from poor reception. In order to achieve an undisturbed primary coverage as large as possible, especially at night time, many high-power radio stations have been equipped with antifading antennas. However, not all of them have been successful.

In 1930, German broadcast stations started to use a single vertical wire or metal rope hung in the axis of a self-supporting wooden tower with a height in the order of half a wavelength and excited electrically at the base. Experience with this kind of antenna in respect to reduction of fading was good. In some cases, the undisturbed night-time primary coverage was increased by 100 percent in area, compared to an antenna with a height of one-quarter wavelength or less. However, the maintenance of the wooden tower proved to be expensive and difficult, and many towers were destroyed by fire or storm. In time they were replaced by self-radiating steel towers which were fed at the base in the same manner as the one-wire antennas. These steel towers were much cheaper, easier to maintain and less subject to hazards. However, they were disappointing in respect to reduction of fading.

Beginning in 1936, several investigators showed that this effect was due to the progressive voltage-current wave along the tower which is superimposed on the standing voltage-current wave as shown in Fig. 1A. This progressive wave carries the energy which is radiated by each element of the antenna or dissipated by losses. In a thin conductor like the one-wire antenna, the progressive wave is small compared to the standing wave and, therefore, the radiation of the progressive wave is almost negligible. In a thick conductor like a steel tower, this is no longer true. The vertical radiation pattern of a simple vertical antenna with height $H = 0.585\ \lambda$ is shown in Fig. 1B, curves 1, 2 and 3, for different values of K.

The distance for which ground and sky wave are equal and, therefore, fading is worst is strongly affected by such modification of the radiation pattern, as illustrated in

Table I—Characteristics of Antenna Operating at 1,195 kc

	Loop-fed			Base-fed
Length of stub in feet between grounded tap and base of mast	58.7	55.1	52.0	*
Height in feet of the current node above ground	−0.8	8.8	16.8	11
Elevation angle in degrees of null of vertical radiation pattern	90	62	54	65
Gain in db in the horizontal direction due to pattern (calculated)	2.15	2.40	2.61	—
Input impedance in ohms of the coaxial transmission line	$100-j51$	$84+j37$	$27+j35$	*
Antenna efficiency in percent, including matching network	73	67	62	73
Losses in stub in percent of the input power	3	10	12	*
Heat losses in percent along the mast (calculated)	0.7	0.6	0.7	0.7
Losses in percent in coaxial transmission line inside mast	1.4	1.4	1.2	*
Ratio of current in percent at current node and at current loop	—	2.9	2.7	26
Voltage in kv across base insulator	5.9	8.3	10.2	9.5
Voltage in kv across sectional-mast insulator	5.7	4.4	6.9	**
Maximum voltage in kv across coaxial transmission line inside mast	6.8	8.0	13.0	*
Standing-wave ratio in coaxial transmission line inside mast	2.2	2.5	7.9	—

* Disconnected

** Shorted

Voltages are for 100 kw rms unmodulated power input.

Fig. 1C. The ground-wave intensity is based on measurements with a certain station as an example. The sky-wave intensity is calculated for perfect reflection from the E-layer as an arbitrary basis of comparison. It is apparent that the distance for which ground and sky wave are equal is reduced considerably with a base-fed mast antenna, compared to a thin vertical radiator, namely from about 135 miles to about 105 miles. This reduction corresponds to a decrease in undisturbed area of 40 percent.

Principle of New Antenna

Around 1940, the author suggested that the shaft of the mast be broken up by an insulator somewhere in its upper part, and that it be excited electrically at this sectional-mast insulator. Although this idea was not in itself new, nobody up to that time had mentioned the advantages of this idea in respect to antifading action.

Disregarding the physical problem of transmitting power to the sectional-mast insulator, by tentatively locating the current source at this point, the basic idea can be illustrated as shown in Fig. 1D. In respect to current distribution, the upper part of the mast works as an open one-wire line and the lower part as a one-wire line terminated by an inductance. According to the flow of energy there is a progressive wave superimposed on the standing wave in each part of the mast, traveling upward in the upper part and downward in the lower part. Each of the two progressive waves is, near the current source, about half as strong as in the case of excitation at the base. The radiation components originating from them cancel each other at least partially because of the opposite direction of the progressive waves. For the sake of brevity, this kind of antenna may be called the loop-fed antenna, in contrast to the base-fed antenna.

As shown in Fig. 2, the current distribution in the lower part of the mast depends upon the induct-

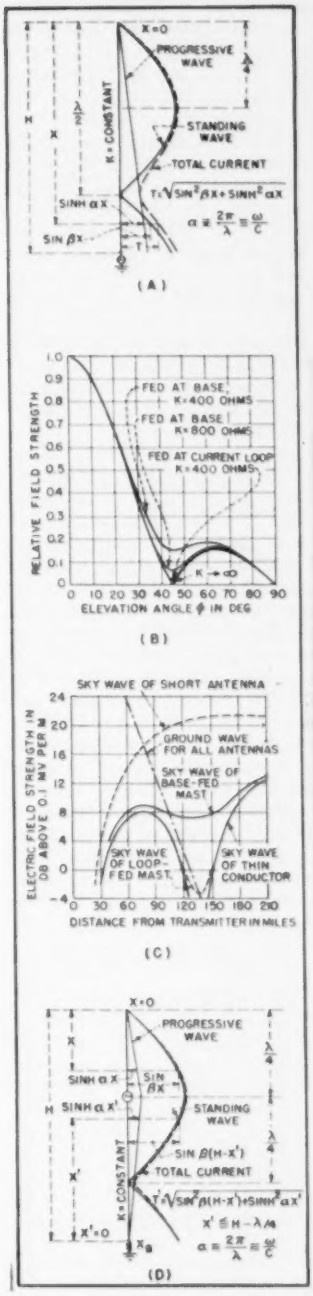

FIG. 1—(A) standing, progressive and total current waves on radiator fed at base, (B) vertical pattern of vertical 0.585-wavelength radiator, (C) sky and ground-wave field strengths, and (D) standing, progressive and total current waves on center-fed radiator

ance which is connected between the base of the mast and ground. This means that the vertical radiation pattern can be controlled by varying this inductance. In order to have a pattern suitable for reduction of fading, it is not necessary to have a current loop at the sectional-mast insulator. Actually a current distribution similar to that in Fig. 2B is more favorable because it allows reduction of the total height of the mast, which can be as low as 0.4 wavelength. Since the inductance at the base can be adjusted conveniently, it is possible to adapt the antenna during operation to a change in ionospheric conditions, as it happens, for example, during spring and fall.

A simple way to feed the antenna at the sectional-mast insulator is shown in Fig. 3A. A coaxial r-f cable is wound as a big coil. Its outer conductor is connected between the base of the mast and ground, representing the inductance mentioned above. The inner conductor of this cable is continued through the inside of the lower part of the mast and insulated from it up to the lower end of the upper part of the mast. This continuation of the inner conductor and the mast itself form a coaxial transmission line, with the mast as the outer conductor. A current equal in phase and magnitude and opposite in direction to the current in the inner conductor flows on the inner surface of the lower part of the mast. No radiation originates therefrom. At the sectional-mast insulator, this current goes around the rim of the mast shaft and continues on the outside surface.

Normally, a tuning and matching network would be introduced at the sectional-mast insulation between the antenna terminals and the coaxial cable. However, in this case it is not necessary. On that part of the coaxial transmission line which is formed by the mast itself and the inner conductor, even a high standing-wave ratio does not matter, both from the standpoints of power losses and break-down voltage of the insulators, because of the great dimensions available. Therefore, it is sufficient to have a matching and tuning network at the lower end of the lower part of the mast shaft where it can be operated conveniently. Even more convenient, the matching network can be installed at the grounded end of the coil of coaxial cable.

In order to determine how much the loop-fed antenna actually improves sky-wave suppression, field strength measurements by airplane were made with a 330-foot high antenna model operated at 1,640 kc. For an elevation angle of 43 degrees, the field strength was reduced by about 14 db compared to the base-fed antenna, and by 23 db compared to a simple short antenna. In effect, the loop-fed mast is about equal to, if not better than, the base-fed one-wire antenna in respect to the sky-wave suppression.

The calculated field strength of the reflected sky wave as a function of the distance, when based on the measured pattern, is shown in Fig. 1C. According to this diagram, the undisturbed primary coverage at night time is increased considerably; namely, by about 30 percent in radius or 68 percent in area, compared to a base-fed mast.

Radio Frankfort Antenna

The first broadcast transmitter which was to have obtained a permanent version of the loop-fed antenna was the 100-kw station in Berlin, Germany. The war prevented this and, instead, such an antenna was erected in 1946 for the 100-kw station in Frankfort-on-Main. Meanwhile, the antenna originally planned for Berlin is thought to have been erected also.

The antenna for Radio Frankfort is a 402-foot steel tower with uniform square cross section. The sectional-mast insulator is at a height of 269 feet so that the upper part of the tower is 133 feet long. The construction of this sectional-mast insulator is similar to that used for station WMAQ.

At the time of the erection in 1947, it was a problem to provide for the necessary inductance between the lower end of the mast shaft and the ground system. This inductance could not be established by a coaxial cable wound into a coil, as indicated in Fig. 3A, because there was no 100-kw cable available. Instead, sections of another mast of identical construction were used to build a kind of short-circuited stub. They are hung up horizontally by strain insulators at a distance of 20 inches above the ground in such a way that they form one big loop with a diameter of 64 feet, as shown in Fig. 3B. One end of this stub is connected to the base of the antenna, the other end is grounded. By moving the tap for the ground connection along the stub, the reactance that is effective between the base of the antenna and ground can be varied conveniently, providing a simple means of adjusting the current distribution along the antenna and, consequently, the vertical radiation pattern.

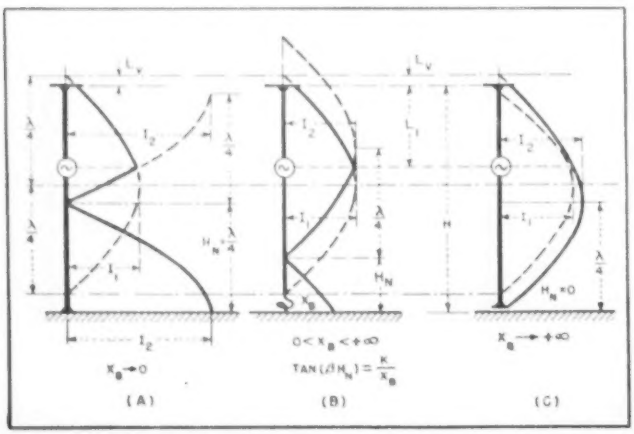

FIG. 3—Effect of variation of series impedance X_B at base of loop-fed antenna on current distribution

In the axis of this stub, the same kind of copper rope as used in the axis of the mast is hung up by strain insulators. At the base of the antenna, it is connected directly to the copper rope in the axis of the antenna. At the other end it is connected to a matching and tuning network. In this way the coaxial transmission line represented by the copper rope inside the antenna and the mast shaft is continued to the point where the outer conductor is grounded. In view of the high voltage-rating of this coaxial transmission line inside the stub, there is no danger of flashing over, even with a high standing-wave-ratio. Therefore, the matching and tuning network could be installed outside the mast shaft in a small tuning house.

The actual performance of this antenna was measured for three different settings of the tap for the ground connection on the stub corresponding to three different radiation patterns. Some of the results are listed in Table I. A total antenna efficiency of 73, 67 and 62 percent was obtained corresponding to a total loss of 1.4, 1.7, and 2.1 db respectively, a relatively high efficiency considering the inexpensive ground system used and the high frequency of 1.2 mc. Even with these losses, the ground-wave field strength is greater than that of a quarter-wave antenna with an efficiency of 100 percent.

Power Losses

About 1.4 to 4.2 percent of the input power was found to be dissipated in the coaxial transmission line inside the tower. This is not too much considering that this coaxial line has a high standing-wave ratio. Another 3 to 12 percent of the input power is lost in the stub. This is due to the low characteristic impedance of the stub, only 62 ohms, which is unfavorable but could not be avoided because of lack of material. Without restriction in material, the losses could have been made much smaller. The balance of about 10 percent loss probably is due chiefly to ground losses. Equally satisfactory are the voltage ratings of the antenna.

Preliminary field strength recordings at night time, at a distance where the fading with a simple quarter-wavelength antenna at the transmitter previously had been serious, showed that the fading at Radio Frankfort is much smaller than the signal of another station equipped with a quarter-wave antenna located at the same place and with almost the same frequency. Final tests have not yet been made in respect to the area undisturbed by fading.

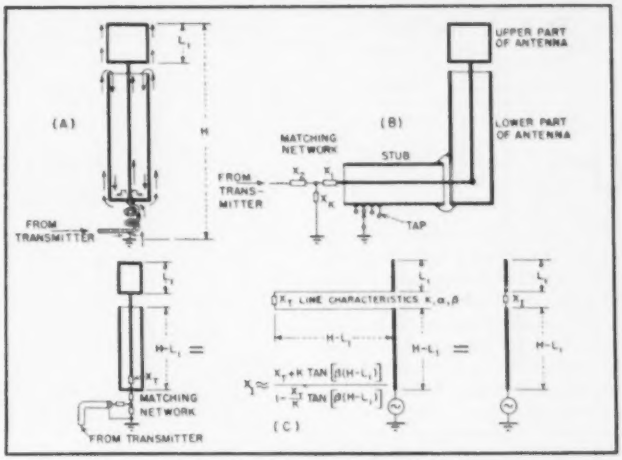

FIG. 3—(A) current flow in loop-fed antenna, (B) loop-fed antenna with matching network outside mast, and (C) equivalent circuit of loop-fed antenna operated as base-fed type

The new antenna also has advantages in respect to its usable frequency range. Full benefit of its antifading action can be obtained in a frequency range of about ±20 percent of the frequency for which it is designed, without any alteration of the antenna itself, just by properly adjusting the tap for the ground connection on the stub. If the antenna is required to operate at a frequency outside of this range, it can be used as a base-fed antenna with the coaxial cable inside the mast working as a stub, shown in Fig. 3C. With this mode of excitation, and with a suitable reactance X_T between the inner conductor and the lower end of the mast, the radiation efficiency at low frequencies is higher than with a simple steel tower because its effective height can be increased by making the input impedance of the coaxial cable inside the mast at the sectional-mast insulator inductive. At higher frequencies the sectional-mast insulator can be used to decrease the electrical height of the antenna in order to obtain a more suitable vertical radiation pattern by making the input impedance of the coaxial cable capacitive. It is also possible to operate the antenna as a simple base-fed mast by short-circuiting the sectional-mast insulator. This possibility may be useful in case of trouble with this insulator.

Acknowledgment is made of the help furnished by Messrs. Gerwig and Graziadei and others involved in the development of the antenna which was carried out under the supervision of the author in the Forschungsantalt der Deutschen Reichspost, Berlin, Germany.

Valuable help in antenna measurements was afforded by Messrs. Haberkant and Behne, employees of Radio Frankfort.

Interest and encouragement were given by R. J. Condon, AMG, and Lt. L. C. Heinzman, then chief engineer of Radio Frankfort.

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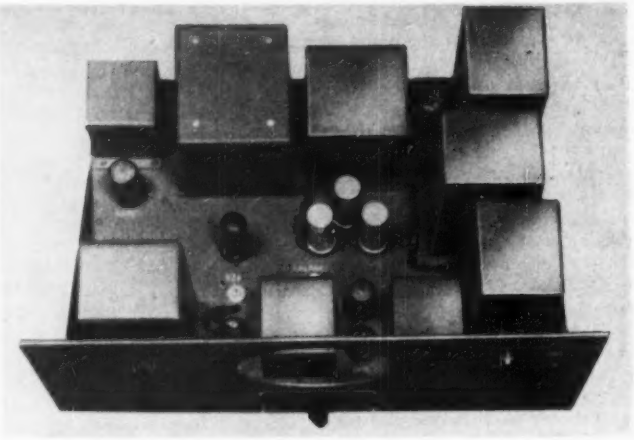

Commercial transmitter speech inverter manufactured by RCA Victor Argentina

An Improved

USERS of wire line, and particularly radiotelephone service, can never be assured complete secrecy of their communications despite laws made for their protection. When circumstances justify the expense of necessary terminal equipment, speech scramblers or inverters are used that make it virtually impossible to decode or unscramble the enroute message without authorization. Owing to the confidential character of such systems the literature gives a very meagre coverage of specific details, although the basic principles have been published.[1]

This article describes an improved speech inverter system employing equipment that is simple in design. In operation, the adjustments to the variable components are not critical and the overall tolerances are fairly broad.

Design Considerations

Common practice in speech inverters is to let the intelligence flow through a low-pass filter that prevents higher frequencies not essential to the intelligibility of speech from passing into the circuits that follow. The limit is often chosen at 2,700 cps.

The speech frequency band, $f_s \leq 2{,}700$ cps, is introduced into a modulator, together with the inversion frequency f_c, which is usually 3,000 cps. There are speech inverters using several inversion frequencies to increase the difficulties for unauthorized reinversion. The method described here can be applied to more complex systems, also.[2] This frequency of inversion is modulated by the intelligence $f_s \leq 2{,}700$ cps. The modulator is generally a balanced type. It produces different frequency groups, the more important being $f_c + f_s$ and $f_c - f_s$. The output from the modulator flows through a second low-pass filter with the same frequency limit of 2,700 cps. By this process the $f_c + f_s$ group is suppressed and the transmitted frequency spectrum is 300 to 2,700 cps.

Frequencies lower than 300 cps produce higher $f_c - f_s$ frequencies than 2,700 cps. They are rejected by the second filter and frequencies higher than 2,700 cps are not introduced into the modulator. The 400-cps frequency in the passband becomes (after modulation and the second filtering process) 3,000 − 400 = 2,600 cps. The 2,600 cps becomes 3,000 − 2,600 = 400 cps. From the lower frequency is produced a higher one and from the higher, a lower one. Thus the frequency spectrum is inverted. The

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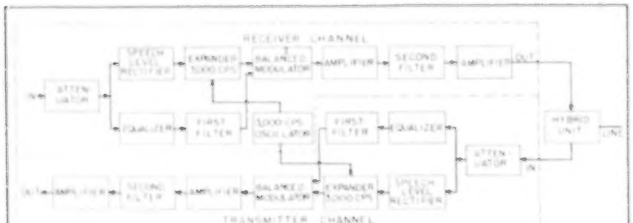

FIG. 1—Two-channel speech inverter showing connection through hybrid unit to line

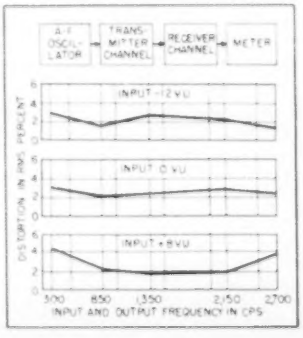

FIG. 2—Distortion in the speech inverter system used for a complete circuit with three input levels

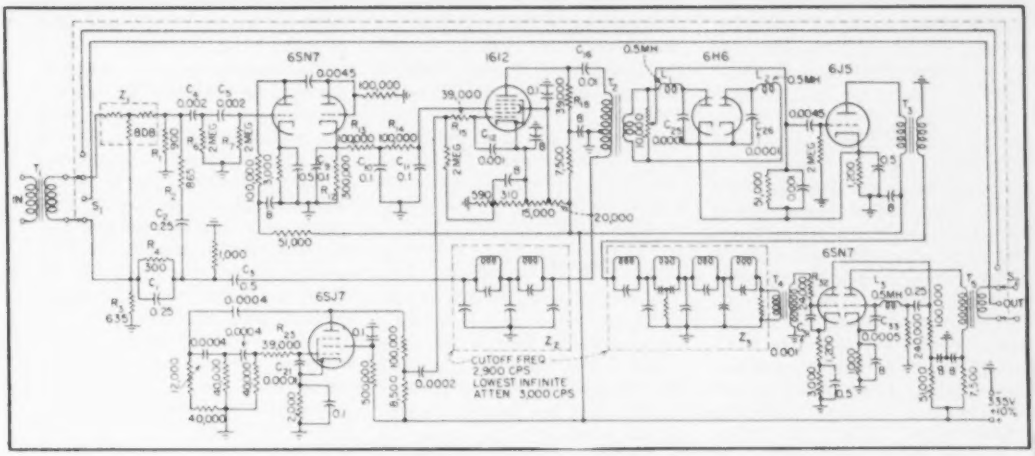

FIG. 3—Circuit diagram of the receiver channel of the speech inverter system

Speech Inverter System

Privacy circuit for radio or telephone line employs double modulation of the conversion frequency and is controlled both by the speech input and the average level of speech input. Frequency response is corrected by an R-C equalizer network. Broad dynamic range, low background noise and low distortion are assured

center frequency of 1,500 cps remains as before. This inverted frequency group is transmitted in the normal manner. A radio-frequency carrier can be modulated with the inverted signal, or the inverted signal is sent over a telephone line.

Unscrambling

If at the receiving end the incoming signal is treated in exactly the same manner as the original input intelligence in the sending-end equipment, the inverted intelligence will be reinverted. The inverted intelligence cannot be understood, but the reinverted signal has the same intelligibility as the original input, provided the process of inversion and reinversion has not introduced extreme distortion.

There are several sources of distortion. The internal carrier frequency of 3,000 cps may be present in the output line because it is not balanced out with sufficient accuracy by the modulator or is not suppressed to the necessary low degree by the second filter. In this case, the 3,000 cps introduces a disagreeable background noise. This tone may be mixed with the hum frequency and harmonics of the power supply. The hum level becomes more disturbing in the speech inverter than in a common amplifier because the modulation factor of the intelligence on the 3,000-cps carrier must be low, as will be shown later.

Further distortion is produced by the modulation of the 3,000-cps carrier. In addition to the lower and upper sidebands the $2\ f_c = 6{,}000$ cps and $2\ f_c$ frequency groups are frequently present in the output of the modulator circuits. The f_c, $2\ f_c$, f_c and $2\ f_c$ frequency groups produce cross-modulation frequencies. Many of these cross modulation products are in the passband of the filter and therefore cannot be eliminated; or they are not in the passband but are not suppressed sufficiently in the second low-pass filter. The $2f_c = 6{,}000$ cps and also $3f_c = 9{,}000$ cps carrier harmonics contribute to the background noise of the speech inverter.

The inverted intelligence is $3{,}000 - f_c$. The $2f_c$ distortion group is in one octave ratio with the incoming intelligence, that is, it is not inverted. The doubling of the input frequency does not impede the intelligibility of the speech. If the level of this distortion is high enough the input direct intelligence can be understood with a common receiver. In this event the purpose of the speech inversion, which is privacy, will not be fulfilled. Furthermore, after passing this tone mixture into a receiver speech-inverter channel, the inverted part of

the speech will be reinverted, and the distortion group of double frequency will be inverted. This kind of distortion produces a dissonant effect.

Distortion

Another type of distortion is often produced by detection of r-f fields from the communications transmitter when the speech inverter is near by. The modulator of the speech inverter inherently tends to detect r-f fields. The leakage r-f field carries inverted speech. This signal will be reinverted and introduced again to the transmitter speech input. Heavy distortion, or in some cases regenerative singing, will be produced in this way.

A type of possible distortion is related to the two low-pass filters. It is hard to meet good frequency response because the lowest frequency of maximum attenuation, which is 3,000 cps, must be near the highest passband frequency. The requirements are, however, that 2,700 cps must be transmitted almost without attenuation. The cut-off frequency of the filters must be chosen, therefore, near 2,800 cps. Considerations of economy often make it difficult to use filters with high-Q coils.[4] Even expensive coils with Q between 100 and 130 do not give satisfactory results.

The passband of 300 to 2,700 cps can be considered the narrowest possible for speech transmission. If the inadequate frequency response of the filters reduces the transmission of frequencies on both sides of the center frequency of this narrow band and if, in addition, distortion frequencies from the inadequate conversion process are present at a considerable level in the speech output, the intelligibility will suffer seriously.

If the level of the conversion frequency, f_c, be high, the distorting terms of the double intelligence, $2f_c$, and the cross-modulation products between the $2f_c$ and $2f_v$ terms become lower. By increasing the ampliture of f_c, however, the unsuppressed portion of the same and of $2f_v$ and $3f_v$ becomes more disturbing. If more filter sections of the same quality are used to attenuate these frequencies the frequency response in the passband will be worse. The requirement of low distortion is contradictory to the requirement of low background noise. It was recognized as a further difficulty that the level of f_c, which is adjusted to the average speech level, is not sufficient for high speech input level and is excessive for low speech input level or for the case of no speech input. The designer must meet contradictory requirements.

The New System

To reduce the distortions to negligibly low values and to assure a low background noise level an improved system has been introduced. The favorable results are obtained by controlling the level of the conversion frequency. The conversion frequency is modulated by the speech input, as in conventional circuits, but it is also modulated by the average level of the speech input. The frequency response is corrected by an R-C equalizer network.

Figure 1 shows the block diagram of the new speech inverter system. The speech inverter is composed of transmitter and receiver channels. The receiver unit contains the 3,000-cps oscillator; the transmitter unit contains the power supply. All other components for the two channels are identical.

The input attenuator reduces the reactive component of the input channel impedance to an insignificant value. The 3,000-cps oscillator excites the expander. The speech level rectifier controls the 3,000-cps output of the expander. If the speech level rises, the expander feeds more 3,000-cps carrier to the balanced modulator. If the speech level is below a minimum value or if there is no speech input at all the 3,000-cps signal in the modulator goes down to a low standby level.

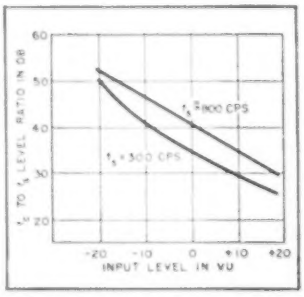

FIG. 4—Conversion and signal frequency levels

This standby level is chosen so low that the residual 3,000 cps and the harmonics of it are better than −50 db below 1 milliwatt at the output of the channel and are consequently inaudible. If the speech level rises, the level of the 3,000-cps tone and the residual of it rises too. Nevertheless, it is not noticeable because it is masked by the speech. Although high-level intelligence is flowing through the speech inverter channel, the 3,000-cps signal and harmonics are still at a relatively low level. As shown in Fig. 2, the rms sum of the remanent 3,000-cps signal, harmonics of it and beats of it with the distortion products of the incoming intelligence remain below a low percentage. The input intelligence will be equalized, and after the first filter, will be fed into the balanced modulator. After the modulator are amplifier stages and a second filter as in the conventional speech inverters.

This speech inverter has no gain or loss. The amplifier stages merely compensate for the losses of the attenuator and equalizer. The normal dynamic range of the input and output is from −12 vu to +8 vu, but no excessive distortion can be observed if the speech level on the line rises to as much as +24 vu (250 mw). With the expander, the level of f_c will be controlled so that a previously fixed ratio will be assured between the f_c and f_v levels. It was determined experimentally that an optimum result can be obtained by keeping the level of the 3,000-cps signal at 25 to 30 db higher in the modulator than the level of the intelligence. This level difference assures the lowest distortion due to the $2f_v$ terms and their beat products. The transmitter and the receiver channels may be coupled by a hybrid unit to the telephone line.

Circuit Analysis

The S_1 and S_2 switch system shown in Fig. 3 inserts or removes the channel from the line. This type of switching can be done because the input and output levels are the same. The intelligence, after passing equalizer elements,

the function of which is described below, reaches one grid of the 6SN7 double triode and also the input terminal of the two-section filter Z_2. The first section of the 6SN7 works as an amplifier, the second section as a diode rectifier and produces with its filter system (comprising R_{12}, R_{13}, R_{14}, C_9, C_{10} and C_{11}) a fluctuating d-c voltage. This voltage is positive with respect to ground and its value depends on the speech input level. The fluctuation is retarded by the time constant of the filter elements. The optimum value of the time constant is about 0.1 second. The fluctuating d-c voltage more or less neutralizes the negative bias of the type 1612 variable-μ pentode. The first grid of the pentode is excited by the 3,000-cps output of the type 6SJ7 oscillator tube. Into one of the primary windings of T_2 is fed the amplified 3,000-cps tone, the amplitude of which is fluctuating with the speech-input level.

The network R_{15}, C_{12} is designed so that transients, produced by the changes of the plate current of the 1612 tube and which are the consequence of sudden speech level changes, cannot be detected on the secondary winding of T_2. The input filter C_1, R_1, C_2, R prevents frequencies below 300 cps, which are out of the passband, from expanding the 3,000 cps level.

In transformer T_2 the filtered intelligence is added to the fluctuating 3,000-cps carrier frequency. The 6H6 tube acts as a balanced modulator to produce the $f_c + f_i$ and $f_c - f_i$ sidebands. The correct setting of potentiometer R_{16} assures the balance. The predetermined level difference between the 3,000-cps and the intelligence on the plates of the 6H6 in the dynamic range is assured by setting of the bias values and the level of the 3,000-cps excitation on the type 1612 tube.

The level of the 3,000-cps signal on the plates of the 6H6, for very low intelligence input, is higher than 30 db with respect to the intelligence. For very high input it is less than 30 db, but not less than 20 db. Nevertheless, the speech inverter cannot be overloaded by loud speaking. With the most excessive input level the $2f_c$ group cannot become higher than about

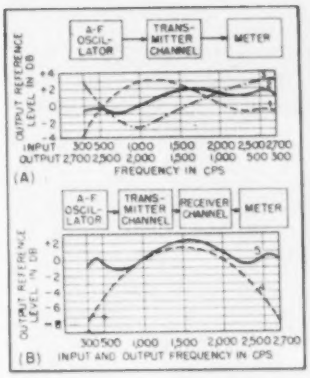

FIG. 5—Curve 1 is response of one channel without equalizer; curve 2 shows response of the equalizer alone; curve 3 is response of one equalized channel. Curve 4 (Fig. 5B) is the frequency response for inversion and reinversion without equalizer; and curve 5 is the same using the equalizer

5 percent of the total; therefore the direct intelligence can never be understood. Figure 4 shows the ratio of the 3,000-cps level to the input intelligence on the plates of the 6H6 modulator tube.

The modulator is followed by a three-stage conventional amplifier with the second filter Z_2 inserted. To make the measurements illustrated in Fig. 2 two channels are connected in series; the output of the transmitter channel is connected to the input of the receiver channel. In this way the complete communication circuit is simulated. The output of the receiver channel has been analyzed for harmonic content with a GR type 636A wave analyzer. The curves show the result of the analysis at 300, 850, 1,350, 2,150 and 2,700 cps for −12 vu, 0 vu and +8 vu speech levels. The distortion curves represent the rms sum of all the frequencies that are present in the output besides the input frequency. Numerous measurements have demonstrated that the analysis at these frequencies gives a good overall picture of the behavior of the instrument so that the straight-line connections between the measured values is justified. The filters used in the speech inverter channel shown in the schematic have Q's of about 25.

The frequency response of the channel, especially in a complete communication circuit using one transmitter and receiver channel, would not be satisfactory without an equalizer. Resistors R_1, R_2, R_3, R_4 and capacitors C_1 and C_2 form an efficient equalizer system. The circuit is similar to the Wien bridge; no infinite attenuation is produced, however, at any frequency. The peaking tendency of the equalizer at the ends of the passband is compensated by capacitors C_3, C_{11}, C_{10}, C_{12}, C_{13}, inductances L_1, L_2, L_3 and resistor R_{11}. Most of these elements serve also with R_{15}, R_{17}, C_{12} and C_{11} in the cancellation of the r-f fields from the inverter channel.

Operational Characteristics

The curves in Fig. 5A show effect of the equalizer on one speech inverter channel and those of Fig. 5B on a complete communication circuit of inversion and reinversion. It is important to equalize both channels.

The frequency response can be corrected by pre-emphasis applied to one end of the transmitter channel and to one end of the receiver channel. The pre-emphasis gains are in this case equal to the sum of the losses at both ends of the passband. This method produces an improved overall frequency response, but for radio communication reduces the distortionless modulation range of the radio transmitter. This reduction of the dynamic range of the transmitter will not result or at least to only a low degree, if both channels are equalized individually.

The author wishes to express his appreciation to H. Zuchenbrojt, RCA Victor Argentina and A. Saenz formerly of the same company, for the valuable cooperation in the design work of the speech inverter and in making the numerous measurements needed during the experimental period.

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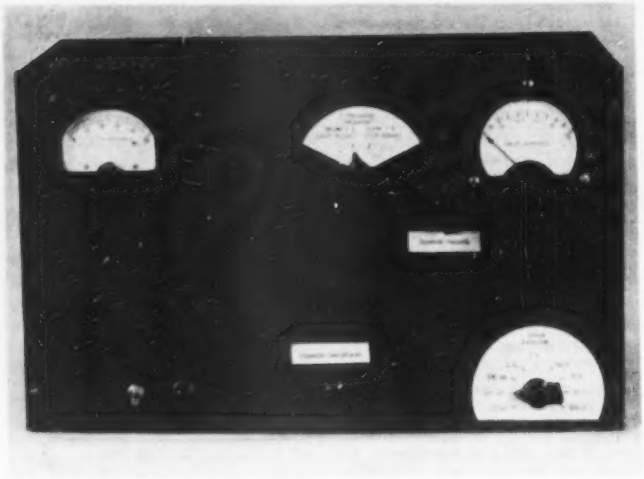
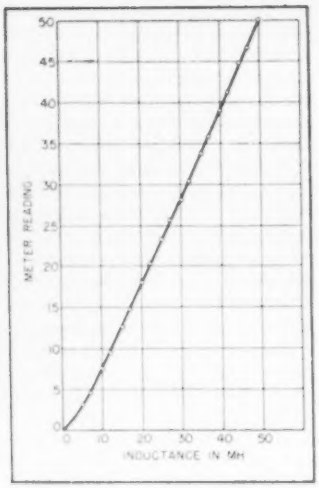


Nine measuring ranges are provided by the switch at lower right of the panel



Calibration curve for the 50-mh range

Inductance Meter

Phase shift through vacuum tube compensates for effect of IR drop in measuring inductance of air or iron-core coils from 5 millihenrys to 100 henrys. Conditions of frequency and current under which the coils operate can be simulated

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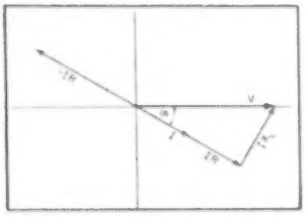


FIG. 1—Vector triangle on which the design is based

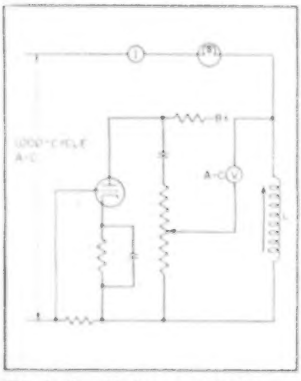


FIG. 2—Simplified circuit of inductance meter

AN INDUCTANCE measuring instrument was developed at the Naval Research Laboratory in connection with an investigation of liquid-level indicators for shipboard tanks, one of which employed a variable inductance that changed linearly with the depth of tank liquid. Although this circuit was developed for a particular application, it can also be used as an inductance meter.

In the measurement of inductance, the chief difficulty usually is caused by the finite d-c resistance associated with any coil, which cannot be separated physically from the reactance of the coil or be neglected as is sometimes possible in the measurement of capacitance.

To eliminate this difficulty, the following method was adopted. The voltage across the unknown inductance is measured with a second voltage, equal in magnitude but 180 degrees out of phase with the IR drop in the coil, introduced into the measuring circuit. This relationship can best be shown by the vector diagram in Fig. 1 where V, IR and IX_L form the vector triangle typical of inductive circuits.

Of these quantities, V alone can be measured physically. If, however, an additional voltage $-IR$ can be introduced into the measuring circuit, the meter will indicate the vector sum of IR, $-IR$ and IX_L which will be directly proportional to the unknown inductance, provided the current and frequency remain constant.

Basic Circuit

The manner in which this voltage is introduced into the measuring circuit is shown in Fig. 2, the simplified circuit diagram of the measuring circuit. The grid signal is taken from the pure resistance in series with the unknown inductance. It will, therefore, be in phase

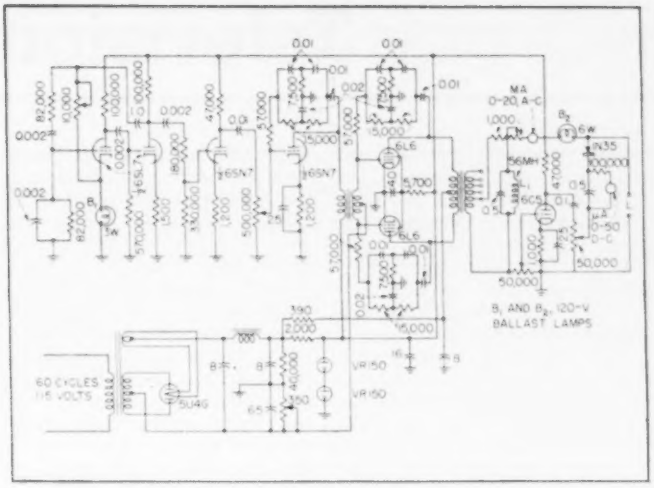


FIG. 3—Complete circuit of inductance-measuring unit and power supply

with the current through the inductance and consequently also in phase with the *IR* drop in the coil as shown in Fig. 1. Thus, the plate signal of the vacuum tube will be 180 degrees out of phase with these quantities, provided the blocking capacitor is large enough to cause only a negligible phase shift. Consequently, the voltage produced across the potentiometer will be in the direction $-IR$ in Fig. 1 and the magnitude of the voltage introduced into the measuring circuit can be adjusted to equal *IR* by means of the variable tap as shown.

Different values of coil inductance or resistance will cause the phase angle α to change, but this change is automatically taken into consideration, since the grid signal is always in phase with the current through the coil and consequently with the *IR* drop in the coil. When properly adjusted, the meter reading will be directly proportional to the unknown inductance and can be calibrated to indicate this quantity directly, provided the frequency and current of the power supply are maintained constant.

A Wien-bridge oscillator-controlled power supply was used because of its excellent frequency stability and the ballast lamp shown in Fig. 2 maintained a substantially constant current.

The a-c meter shown in Fig. 2 should have a high impedance so that the meter current flowing through the grid resistor will have a negligibly small effect on the grid signal. In the model tested, since simplicity and ruggedness were desired, a d'Arsonval type meter (20,000 ohms per volt) with a rectifier was used quite satisfactorily. However, a vacuum-tube voltmeter is preferable due to its higher impedance and more linear characteristics.

In the model tested, the power was supplied by a 1,000-cycle Wien-bridge oscillator with suitable amplifier, equipped with bridged-tee feedback networks to reduce the harmonics to a negligibly small value. The complete circuit is shown in Fig. 3. Care should be exercised in its construction to minimize the frequency drift as the circuit components warm up or else some means should be provided so the circuit will quickly stabilize.

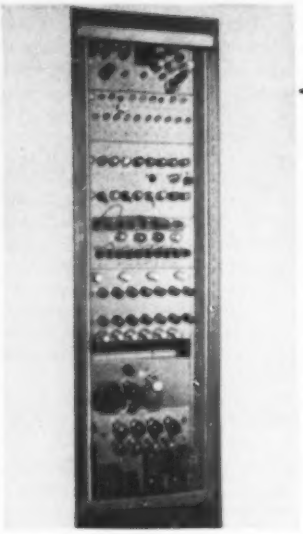
In the operation of this meter, the current and frequency through the unknown inductance are set at predetermined values and the potentiometer in the plate circuit of the inverter tube adjusted to the value which provides a minimum reading on the a-c meter. This minimum reading will indicate the value of the unknown inductance directly, when properly calibrated.

High Range

For extending the range of the meter, it is necessary to change the current through the unknown inductance, the frequency of the power supply or the sensitivity of the indicating meter. By shifting to 100 cycles, the model constructed measures iron-core inductances as high as 100 henrys. The only appreciable error in such a meter, if properly constructed, is due to the fact that it neglects the distributed capacitance in the unknown coil. This error, however, is minimized if a coil current is used which is appreciable with respect to the current due to the distributed capacitance.

This meter can also be used to measure the change in inductance over a given range by inserting a capacitor in series with it of the proper value to balance the initial inductance. When used in this manner, it is particularly important that the harmonics in the power supply be reduced to a low value; otherwise an appreciable error will be introduced in the meter reading, which is most noticeable near the balance point. This circuit can also be used to measure capacitance directly, but the meter reading will no longer be linear, since reactance is an inverse function of capacitance.

The circuit described can be used for coils having a wide range of values of both inductance and resistance and works equally well on air-core or iron-core coils. If designed and calibrated for a given set of conditions the inductance of iron-core chokes or transformers can be measured under the conditions of frequency and current at which they will operate. It is particularly suited for the measurement of the change in inductance in a given circuit where the circuit constants (except inductance) are fixed. Such a circuit can be initially balanced and calibrated and the meter will provide a continuous indication of the change in inductance without further attention.



Sync generator and power supply in a single rack having a total of 93 tubes

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WITH THE EXCEPTION of one slug-tuned oscillator coil, the sync generator to be described contains no variable elements. This design is in direct contrast with conventional synchronizing equipments that incorporate dozens of variable potentiometers. All pulse widths, all pulse positions and the pulse number are determined by a system of binary counters in conjunction with a delay line.

The importance of stability is readily appreciated when it is realized that composite sync and blanking waves for television contain pulses of six fundamental widths at three basic frequencies held in correct phase relationship to a tolerance of 0.3 microsecond. In this generator, determination of sync and blanking waves is a function of circuit configuration and is not subject to variation by operators.

No attempt was made to reduce the number of tube envelopes. A total of 93 tubes is used in this generator and its power supplies. This figure is some 20 tubes in excess of the number common to present designs. The cost of the extra tubes is counter-balanced by stability and freedom from adjustment. All tubes, except those in the basic 31.5-kc oscillator and lock-in circuits, act merely as switches. They have only two operating states—plate-current cutoff and plate current saturation. Many tubes are buffers with short duty cycles.

The leading edges and trailing edges of sync, blanking and driving signals are precisely positioned by a delay line, and inherently stable device. The widths of the vertical components in the sync and blanking signals are fixed by making them a definite number of cycles or pips wide as derived from the basic 31.5-kc oscillator. The exact number is determined by binary counters. All generator output signals are independent of R-C circuits or charge accumulation circuits. In general, the generator exhibits a computer-like behavior in that the output signals are precisely correct or they are completely incorrect.

Use of Delay Line

The basic principle of operation is illustrated in Fig. 1. A sharp pip is applied to a delay line having a high cutoff frequency to retain the steep wavefront. The pip is extracted at tap 1 to actuate the flip-flop oscillator to the ON condition. This same pip is extracted from taps 2 or 3, at a later time, to return the oscillator to the OFF condition. The rectangular pulse produced has the positional stability of the recurrent pips and the pulse width is accurately established by the delay line. By connecting to various taps along the line through switches, the pulse width or position is accurately altered.

In the final equipment, keyer tubes actuated by keying signals replace the switches of Fig. 1. The keying signals serve to position or control the width of the flip-flop oscillator pulses to predetermined requirements. Thus, by using various pips from a delay line keyed in by different keying waves, it becomes possible to generate a desired complex rectangular waveform in one flip-flop oscillator. In the event that the oscillator receives several successive ON and OFF pips, only the first of each group is significant.

Another important characteristic is the immunity of the oscillator pulse to variations in the keying wave. In the sync generator, the rise and fall times of the keying waves may vary in the order of 10 microseconds without affecting the generated pulses. This characteristic leaves the pips in control of the exact timing of rectangular waves.

Figure 2 indicates the manner in which the entire RMA sync signal is generated in one flip-flop oscillator into which are injected suitably keyed pips. Keying wave *G* in Fig. 3, occurring at the horizontal sweep rate is combined with the three principal vertical keying waves *A*, *B* and *C* to produce a composite keying signal operating keyer K_o. This keyer passes the ON pips from tap 3 to the oscillator at *H* rate during the picture interval and at 2*H* rate during the three vertical intervals. Thus, tap 3 on the delay line precisely determines all the leading edges of the sync signal.

Similarly, the varying trailing edges of the sync signal are determined by injecting the OFF pips to the flip-flop oscillator. There are three fundamental widths in the horizontal component of the standard sync signal—the equalizing pulse (2.25 μsec), horizontal sync (4.5 μsec) and vertical serration width (4.5 μsec). These widths are established by taps 4, 5 and 1 respectively, and selected by keyers K_w, K_x and A_o. Vertical keying signals *A* and *C* are combined to operate K_x and hereby furnish OFF pips from tap 4 during the two equalizing intervals before and after the vertical sync. Tap 4 thus determines width of equalizing pulse.

The horizontal sync width is determined by the OFF pip normally keyed in from tap 5 through K_w. This keyer passes OFF pips at all

Synchronizing Generator

Standard synchronizing, blanking, horizontal and vertical driving signals are obtained from a generator based upon binary counters without variable controls. Sync signal parameters are fixed by circuit configuration rather than by R-C or charge accumulation circuits. Stability is high and independent of power supply regulation

times except when K_{10} is keyed out during the vertical sync period. The fact that the oscillator is receiving OFF pips from tap 5 during the equalizing intervals is of no consequence since the oscillator is already receiving OFF pips from tap 4 during these intervals. The trailing edge in the vertical serrations is established by OFF pip 1 through amplifier A_4. These OFF pips are supplied to the oscillator continuously but are only effective during the vertical sync interval when all other OFF pips are absent. The complete sync signal as generated by the flip-flop oscillator is passed through clippers for cleaning both top and base of the composite wave.

The mixed blanking signal is similarly synthesized. The composite keying signal which keys K_8 for the sync ON pips also keys K_7 to supply ON pips to the blanking oscillator. These pips originate from tap 2 on the delay line. The time displacement between taps 2 and 3 establishes the sync front porch. Blanking OFF pips originating from tap 6 are normally keyed in during the picture interval. Time difference between tap 2 and 6 represents the horizontal blanking width. Keying wave F keys out these OFF pips during the vertical blanking interval to establish the vertical blanks that are required.

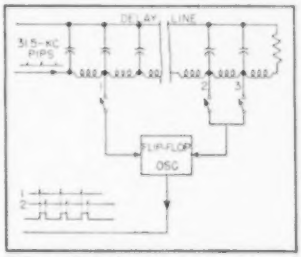


FIG. 1—Method of generating rectangular waves

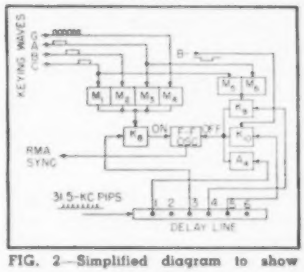


FIG. 2—Simplified diagram to show sync synthesis

It should be noted that the oscillator receives ON pips during the entire vertical blanking period. Only the first one is significant since there are no OFF pips during this period. Time differential between taps 5 and 6 determines the horizontal back porch. It will be apparent that in this method of generating the blanking signal, the leading and trailing edges of the vertical blank are coincidental with those of the horizontal and therefore no last-line jitter can occur at either top or bottom of the frame.

Driving Signals

A similar but less involved approach is made in generating the horizontal and vertical driving signals, indicated in Fig. 4. All keying signals originate from the 31.5-kc basic oscillator that is frequency-controlled by the usual phase discriminator and reactance modulator circuits. The sine-wave output from this oscillator is clipped and differentiated to produce sharp pips that are amplified to approximately 75 volts positive polarity for the delay

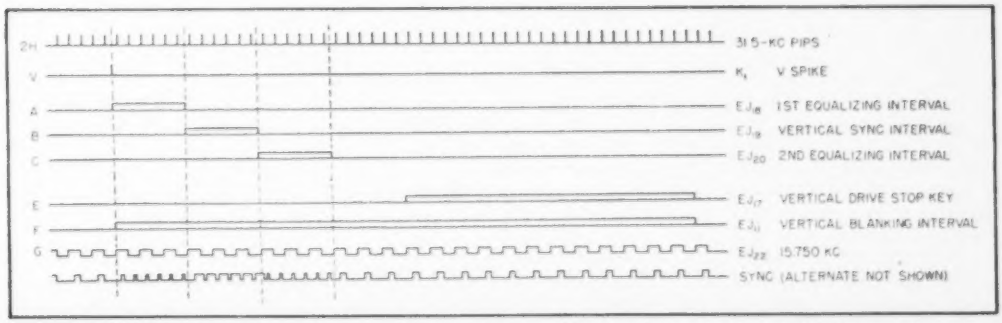


FIG. 3—Relations existing among the various waveforms at different points in the circuit (not drawn to scale)

line input. Binary counter EJ_{20} driven by these $2H$ pips yields the H keying square wave G. The process for generation of keying waves at the vertical frequency begins with division of the 31.5-kc pips by the required 525 divisor, using a cascaded binary type of counter. The normal power of two count is reduced by count-advance feedback.

Group Counts

The counter chain is broken down to groups having counts of 7, 5 and 15 which facilitates checking circuit operation. The 60-cycle output operates a keying system to select every 525th pip from the 31.5-kc train of pips. This circuit assures a stable phase relationship between the 60-cycle spike and delay pips.

The 60-cycle spike initiates EJ_{11} to provide wave F and to key on keyer K_2. This 60-cycle spike also initiates ring counter EJ_{16}, EJ_{17} and EJ_{18} in which the transfer signal is the output from the count-of-six counter. The consecutive rectangular waves A, B and C available at each stage of the ring counter are exactly six pips wide and the group occurs at 60 cycles. These represent the three important vertical intervals—first equalizing, vertical sync and second equalizing.

Eccles-Jordan circuits EJ_{21}, EJ_{19} and EJ_{11} serve to end the blanking period by restoring EJ_{11} to its normal condition. The width of the blanking period is determined by the total count of counters EJ_{11} through EJ_{21}.

In the development of this sync generator it became apparent that there was no place for delicately poised circuits. The loading of a binary counter by directly coupling to a following stage impaired the counter's immunity to variations; buffer tubes were consequently considered an advisable tube expenditure. Grounded-cathode designs were used in the various counters to simplify construction. The grids of such counters provide square waves whose bases are at ground potential, thereby allowing direct coupling to keyer tube grids. Conventional methods for injecting the transfer signal into the ring counter did not yield the desired reliability. The circuit evolved, using a type 6L7 as an injector, leaves nothing to be desired in this respect. One of the injector control grids is connected to the counter stage, rendering the injector insensitive to the transfer pulse. Sensitivity to the transfer pulse is developed slowly only by the stage ready for it.

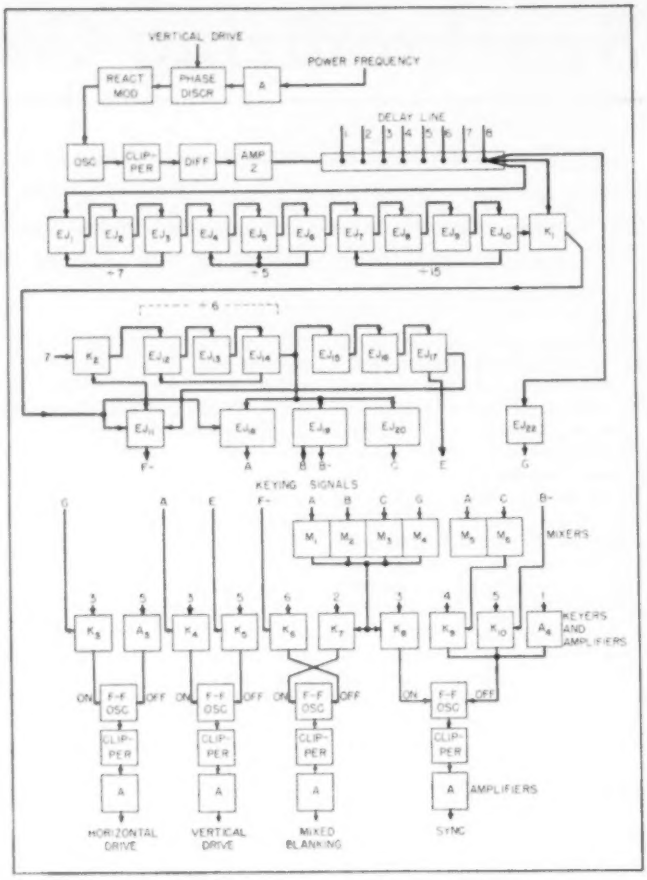


FIG. 4—Interconnections for complete sync generator

Design of delay lines is described in the literature. The principal requirement in this instance is a high-cutoff frequency (greater than 2 mc) with losses low enough to yield a 15-v pip at the end of the line, assuming that the input of the line is driven with a type 6L6 or similar tube.

The requirements for the flip-flop oscillators are rather stringent. They must be capable of being excited to a new condition and all potentials throughout the oscillator circuit must reach equilibrium in less than 2 microseconds. If the oscillator is not designed in wide-band fashion, it will not respond to the second of two closely spaced ON and OFF pips as required for generation of the equalizing pulse.

Power supply requirements for the generator are not critical. A plate voltage of 150 volts reduces danger of component breakdown and eliminates cathode and screen resistors that would be necessary to limit plate current if a higher plate voltage were used. The total plate drain is approximately 500 ma. The generator was operated successfully for some time from an unregulated supply. A regulator was subsequently incorporated, primarily for protection from heavy power-line transients.

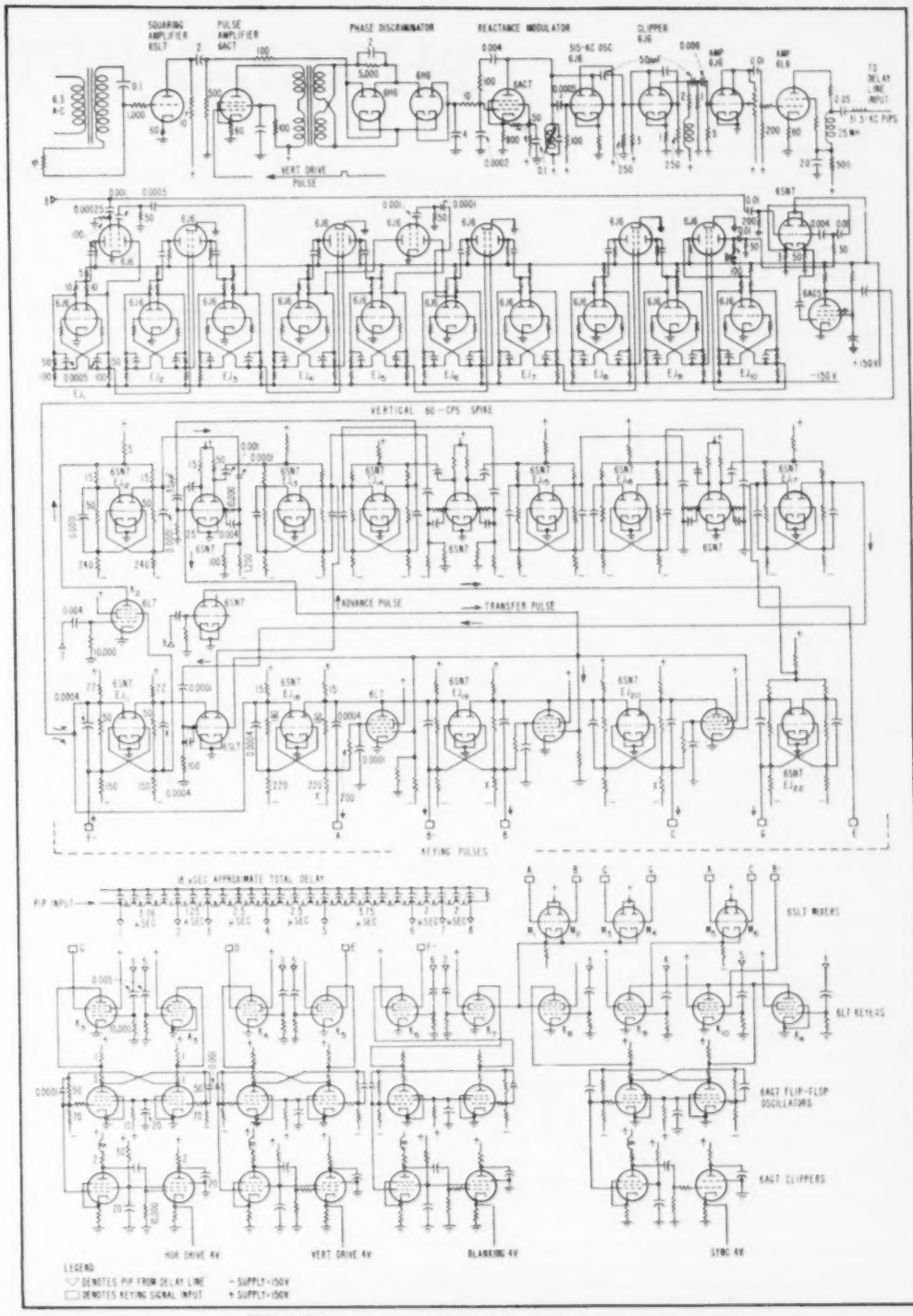


FIG. 5—Schematic representation of the complete sync generator

PHASE-SHIFT

By DeWITT H. PICKENS and J. N. VAN SCOYOC

Armour Research Foundation
Chicago, Illinois

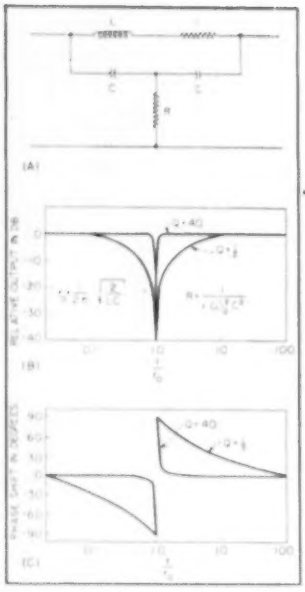


FIG. 1—Phase shift introduced by a bridged-T network changes in sign as frequency passes through null frequency

ANYONE who has conducted laboratory investigations within a given frequency range has at some time or another felt the need for an easily constructed band-pass filter. The presence of undesired signals such as a-c hum and random noise near the frequency region of intelligence-bearing signals has led to an extensive investigation of networks which will eliminate these undesirable frequency components. The object of this paper is to describe the operation of a band-pass filter which employs components normally found in all laboratories, and which does not involve any complicated calculations in its design and construction. This type of filter may in many cases be used in place of the more conventional type filters with their complicated and specialized components.

The basic circuit of the phase-shift filter is a combination of conventional bridged-T networks. The circuit diagram for a bridged-T network is shown in Fig. 1A. Figure 1B shows the attenuation characteristics of bridged-T networks and clearly illustrates the effect of Q on the frequency response of the network. An analysis of the network will yield the expression for the null frequency f_o and the condition for an absolute null in terms of the network parameters.

$$f_o = \frac{1}{2\pi}\sqrt{\frac{2}{LC}}$$

$$R = \frac{1}{r\omega_o^2 C^2}$$

The latter equation expresses the conditions for null.

Figure 1C is a generalized phase-shift characteristic for the bridge-T network. It will be noticed that the sign of the phase shift changes as the frequency passes through the null frequency of the network. It is this characteristic that makes it possible to combine the output of two bridged-T networks to form the attenuation characteristic of a bandpass network. If the outputs of two similar bridged-T networks, whose null frequencies are separated by a given increment, are combined in such a manner that the output of one network is subtracted from the other, the phase

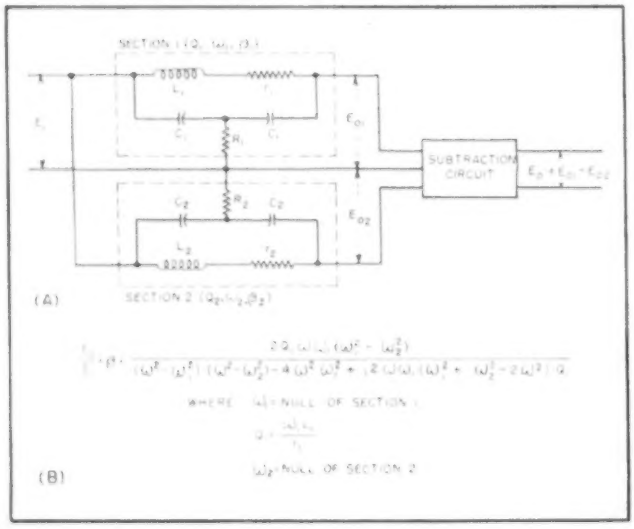


FIG. 2—If the output of a bridged-T network is subtracted from that of a similar network whose null frequency is close to that of the first, the phase relationship between the two outputs is such that they will add near the null frequencies and subtract outside the band between the null frequencies

BAND-PASS FILTERS

Double bridged-T network using readily available components provides good band-pass characteristic at minimum expense. Usable bandwidth depends on allowable dip between null points of the individual bridged-T networks

relationship between the two outputs is such that they will add in the vicinity of the null frequencies and subtract outside the band between the null frequencies. The overall combination has the characteristics of a band-pass filter.

Basic Circuit

Figure 2A is a block diagram of the basic phase-shift filter circuit using the output of two bridged-T networks as an input to a subtraction circuit. Each of the two T sections has its own Q, null frequency and transfer function β. The derivation of the transfer function for the composite circuit is a lengthy and complex process and no time will be devoted to its derivation. The resulting transfer function is shown in Fig. 2B. This expression shows that the transmission characteristic of the phase-shift filter is a function of Q and the null frequencies of the two T sections.

Differential combination of the output of the two T sections which make up the active branch of the phase-shift filter may be accomplished in many different circuits. Several of these circuits will be discussed in detail in a later section of this paper. Basically, these circuits may be grouped in two general classes: (1) direct subtraction circuits, and (2) phase inversion and addition circuits.

Figure 3 is a block diagram of a phase-shift filter in which the desired output is obtained by direct subtraction of the outputs of the two T sections. Figure 4 shows the

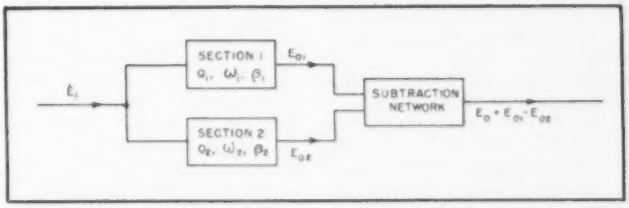


FIG. 3—Direct subtraction method for combining outputs of bridged-T networks

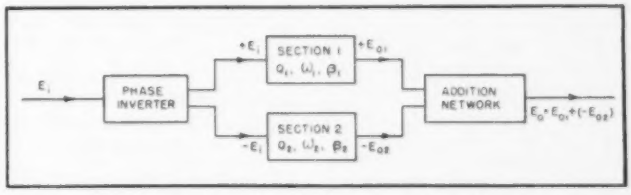


FIG. 4—Phase-inversion—addition type of phase-shift filter

block diagram of the method in which the phase of the input to one T section is inverted and the outputs of the two T sections are put into a summation circuit. The difference between the two transmission characteristics of the T section is then obtained by direct addition of the two signals, one of which has had its phase inverted.

Experimental tests were conducted on a phase-shift filter utilizing two air-core speaker field coils as the inductances in the two T sections. Figure 5 is the circuit diagram of the tested circuit, showing the combining circuit used. The gain characteristic of the cathode-coupled circuit used as a subtraction circuit in these tests was such that the input to one tube had to be attenuated by potentiometer R so that the output represented the true difference between the input signals. This characteristic of the cathode-coupled subtraction circuit will be discussed in greater detail in a later section of this paper.

Figure 6 is a family of attenuation curves obtained by increasing the frequency increment between the null frequencies of the two bridged-T sections. This was accomplished by decreasing the capacitance in one section and resetting the value of the resistance to give an absolute null. The null frequency of one T section was held

constant at 1,800 cps. It will be noticed that as the bandwidth is increased, by increasing the separation between the null frequencies, the output decreases in the passband. This characteristic of the phase-shift filter is similar to that of the conventional tuned coupled circuit. Further investigation revealed that as the bandwidth is increased for a given center frequency this dip in the passband will increase to a point where the circuit is no longer usable as a filter with a single passband.

Passband Dip

Before any attempt is made to design a phase-shift filter, the degree of dip in the passband which can be tolerated must be established. This amount of dip is dependent upon the particular application of the filter. Primarily, though, it must be remembered that limitation of the amount of allowable dip also places a limitation on the maximum bandwidth that may be used. Some median must be established between the width of the passband and the output dip in this passband. Again, this choice will depend on specific applications.

Figure 7 is a family of experimentally obtained universal curves which may be used to determine the allowable bandwidth for a given output dip within the passband. As a matter of choice the curves were obtained for arbitrarily chosen output dips of 3 db, 1.5 db and 0 db. Knowing the midfrequency and the Q of the coils at this frequency, these curves may be used to establish the maximum bandwidth that may be used. The design process to be followed is as follows: The values of the abscissa at the passband limit points on a particular curve, when divided by the midfrequency Q, will yield the ratio of the bandwidth to midfrequency. Knowing the midfrequency, the allowable bandwidth may then be established. The reverse of this process may be used to determine the value of Q necessary to obtain a given passband with a given output dip.

In using these curves it must be kept in mind that they were obtained by laboratory experimentation and do not represent theoretical calculations. The accuracy of the experimental processes was held within the limits of normal laboratory measurements; however, there are present some inherent sources of error. Particular among these is the error imposed by the subtraction circuit. As previously stated, the subtraction circuit used in this experimentation was a cathode-coupled differential amplifier. The initial balance was obtained by attenuation of one input signal.

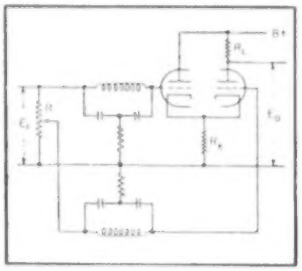


FIG. 5—Phase-shift filter and cathode-coupled subtraction circuit

The degree of error in the output of this circuit is dependent upon the level of the output signal. At the extreme ends of the curves, where the frequency is quite a distance from the midfrequency, the output level became very small so that the error in initial balance of the cathode-coupled circuit became more prominent. At these removed points on the curves, the curve represents more the unbalance and distortion in the amplifier circuit than the actual attenuation characteristic of the phase-shift filter. This residual error would be minimized by cascading identical stages.

To prevent this type of error from becoming of such magnitude as to diminish the utility of the filter circuit, a subtraction circuit whose initial balance can be effected to a very fine point must be used. Several types of familiar differential amplifier circuits and phase-inversion circuits may be used, the choice of which depends upon the relative merits of each. Some of the more familiar circuits of these types are: (1) cathode-coupled amplifier, (2) cross-coupled amplifier, (3) phase-inverter circuit, and (4) push-pull input circuit.

Differential Amplifiers

Figure 8A is a circuit diagram of a cathode-coupled differential amplifier. This circuit is perhaps the simplest of the differential amplifier circuits. The initial balance of this type of circuit is obtained by potentiometer R. The presence of load resistance R_L in the plate circuit of only one tube establishes a different operating point for the two tubes. As a con-

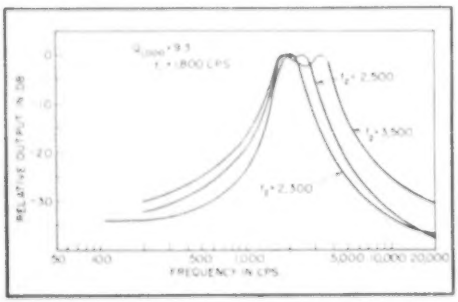


FIG. 6—Attenuation characteristics for phase-shift filter using air-core coils

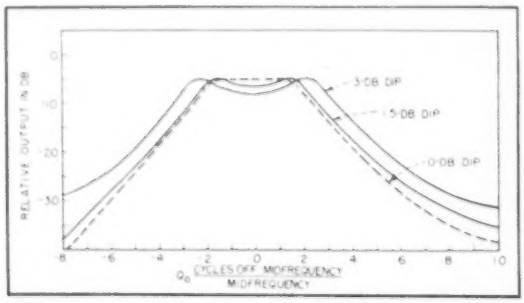


FIG. 7—Universal curves for phase-shift filters derived from experimental data

sequence, the gain from the grid of V_2 is always greater than that of V_1. To offset this difference of gain, the input signal to the grid of V_2 must be attenuated by means of potentiometer R until zero output is obtained with a common input.

Figure 8B is a circuit diagram of a cross-coupled differential amplifier. This circuit affords the highly desirable features of low sensitivity to hum and large dynamic range of input signals, with an output that is proportional to the difference between the two input signals. The tubes V_1 and V_4 are connected as cathode followers, with the cross coupling between V_2 and V_3 providing phase inversion. The input voltage of V_2 is the difference between the output voltages of V_1 and V_4. The input voltage of V_3 is equal to this same voltage but opposite in phase. The output voltages of V_2 and V_3 will then be proportional to the difference between the impressed voltages on V_1 and V_4 but opposite in phase. The overall output will then represent the difference between the two input signals if any degree of symmetry in tube or circuit parameters has been maintained.

To offset any dissymmetry in the circuit, potentiometer R has been inserted. The initial balance of the circuit may be effected by varying R to a point where zero output is obtained with the same signal applied to V_1 and V_4. Since the circuit conditions previously described exist whether the input signal is impressed on both V_1 and V_4, this circuit may be used as a push-pull input stage or a balanced phase inverter.

Figure 9 is a circuit diagram of a phase-inverter subtraction circuit. Its operation is based upon the fact that the plate and cathode voltages of a tube are 180 degrees out of phase with each other. If the plate and cathode resistance of V_1 and V_2 are of equal magnitude then identical inputs to both V_1 and V_2 will produce voltages across the plate of V_1 and the cathode of V_2 which are equal and opposite. When an initial balance is obtained by means of R_b, the output voltage E_o will be proportional to the difference between the two input voltages E_{i1} and E_{i2}.

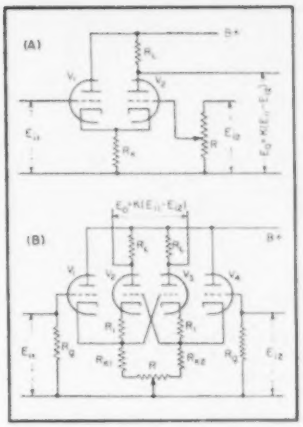


FIG. 8—Cathode-coupled (A) and cross-coupled (B) differential amplifier circuits

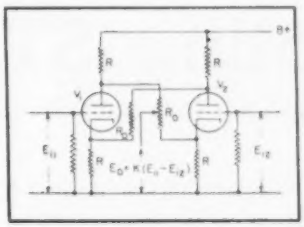


FIG. 9—Phase-inverter subtraction circuit

A system utilizing a balanced center-tapped transformer represents the simplest means of obtaining two equal and opposite voltages

Choice of Circuits

The choice of which circuit to use as a combining circuit in the phase-shift filter is dependent upon the relative merits of each. Perhaps the simplest method is one utilizing the balanced push-pull output from a transformer. The use of this circuit depends solely upon its availability since the design and construction of such a transformer contributes much complication.

The ease of design and construction of the phase-inverter circuit seems to indicate a high degree of utility; however, it must be pointed out that any difference between the resistances used in the plate and cathode circuit will result in an error in the output signal.

The cathode-coupled amplifier is the median between circuit complexity and performance as a differential amplifier. This circuit, involving two tubes, performs very well as a part of the phase-shift filter. The experimental processes conducted in this investigation indicated that the initial balance of the circuit could be made to the degree of approximately —50 db.

The versatility of the cross-coupled amplifier and its adaptability for use as either a phase inverter or a differential amplifier makes its use very desirable. The condition of initial balance may be effected quite easily. Its low susceptibility to hum and large dynamic input characteristic are also indicative of its utility. The objectionable feature of this circuit is the physical size of the circuit wherein four tubes are required. Again the choice between performance and circuit complexity is an arbitrary one and rests with the particular function to which the filter is applied.

Summary

The similarity of the phase-shift filter's attenuation characteristic to that of the tuned coupled circuit seems to indicate its most important possibility. The performance of specific tuned coupled circuits can be approached to a satisfactory degree by use of a phase-shift filter. In doing so, the complex problems of coil design and coupling factors are eliminated. The simplicity of the phase-shift filter with respect to the tuned coupled circuit, in view of their similar attenuation characteristics, is an argument somewhat in favor of its use. The authors feel that the advantages of this circuit are more pronounced in the audio-frequency range.

The phase-shift filter, with its lack of complex design and construction procedure, lends itself to many applications. At first glance it may appear that an even better performance could be obtained by use of m and k type filters; however, the use of such filters involves an extensive design procedure and many components of specific values. Calculations have shown that if the same number of components were used in cascaded sections of the phase-shift filter its performance would approach that of m and k type filters.

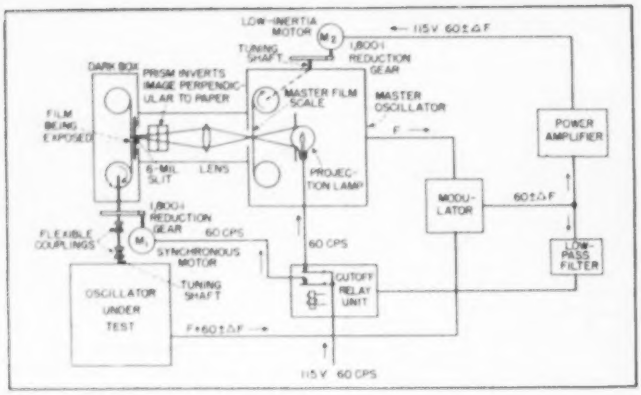


FIG. 1—Speed of master film is determined by difference in frequencies of master oscillator and oscillator under test. Calibration process which originally took 22 hours can now be done in 2 hours

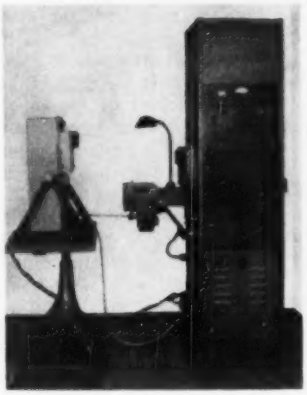


FIG. 2—Tuning knob of oscillator under test (left) is coupled to reduction gear mounted beneath dark box (center)

Calibrating STRIP-TYPE

Two r-f generators, a standard and one to be calibrated, are driven through their ranges in frequency synchronism. Calibration markings on 40-foot master film-strip scale are projected onto unexposed film which becomes frequency scale for new oscillator

By F. W. SCHRAMM

Western Electric Company, Inc.
Kearny, New Jersey

CERTAIN TYPES of oscillators used by the Bell System for testing and maintaining coaxial-cable terminal and repeater equipment require a continuous scale marked at 2-kc intervals over a range of 50 to 3,500 kc. To provide close frequency settings over this 70-to-1 frequency range without switching scales, a continuous length (approximately 40 feet) of 35-mm film is used as a frequency-setting dial.

Calibration of such scales presents a problem. Manual calibration takes about 16 hours, and printing the scale lines and numbers another 6 hours. The photographic calibrating system described here prints the 2-kc markers within ±400 cps in a total time of 2 hours. Its operation is fully automatic and virtually foolproof.

Basic System

The block diagram of Fig. 1 shows the fundamental circuit and the optical arrangement employed. The tuning shaft and the unexposed film scale of the oscillator being calibrated are rotated mechanically by a line-operated synchronous motor through an 1,800-to-1 reduction gear. This motor M_1 causes the oscillator frequency range and film scale to be traversed simultaneously at a constant rate from one end to the other.

The tuning shaft and the accurately printed film scale of the master oscillator are rotated through an identical reduction gear by another 60-cps motor M_2. This motor gets its power from an amplifier whose input is furnished by a modulator circuit. The modulator output signal is the difference between the frequencies of the two oscillators; and when the two oscillators are exactly 60 cps apart in frequency, motor M_2 runs at the same speed as M_1, and the film printed for the oscillator under test will be identical to that of the master oscillator.

If, however, turning the shaft of the oscillator being calibrated causes its frequency to change at some rate different from that of the master oscillator (as is the case—otherwise calibration would be unnecessary), the modulator output signal will differ in frequency from 60 cps by the amount which the two oscillators stray from their normal 60-cps separation. This change will cause a change in the speed of M_2, and thus in the scanning rate of the master oscillator, in such a way that the deviation is immediately

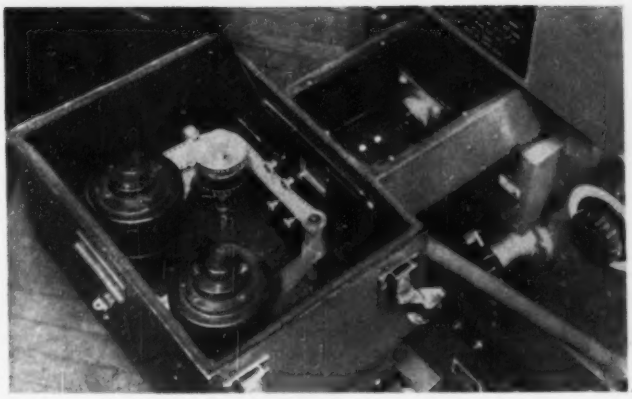


FIG. 3—Two-kilocycle marking lines from master oscillator (right) are projected through optical system to 35-mm film strip of oscillator under test which runs in a light-tight box shown here with cover removed

DIALS

remedied. Thus the two oscillators are synchronized, and the symbols printed on the blank film scale of the test oscillator will be accurately positioned, except for a fixed 60-cps displacement which can easily be compensated for, as will be explained later.

Light from a projection lamp in the standard oscillator shines through the film scale markings of the standard, through an optical system, and through a 0.06-in. slit onto the unexposed film of the oscillator, as shown in Fig. 1. The film is processed in a photographic laboratory and then becomes the frequency-setting scale for the new oscillator.

Calibration Setup

When an oscillator is ready for calibration it is positioned so that its main tuning knob may be attached to the flexible-shaft connection on the reduction gear box as shown in Fig. 2. Power is supplied to the two oscillators from rectifiers mounted in the rack below the master oscillator in the test set.

Since this is a photographic process, the use of a dark chamber is necessary. However, by placing the film to be exposed in a small dark box immediately in front of the master film, the need for a dark room large enough to hold both oscillators is avoided. As shown in Fig. 2, the dark box is fastened to the front of the master oscillator. The box, Fig. 3, contains the optical system and a film-drive mechanism which is a duplicate of that in the oscillator to be tested. This film drive is coupled to the oscillator under test through the flexible shaft so that the film is driven at the same rate as if it were in the oscillator itself. A notch is provided on the sprocket wheel of each drive unit and a mark is placed on the film opposite the notch to provide a means of orienting the scale properly when the film is later mounted in its oscillator.

The lens in the dark box, besides focusing on the film, also inverts the image. Since the film in the box travels in a direction opposite to that in the master oscillator the longitudinal inversion is satisfactory, but to reinvert it crosswise of the film the prism is used.

Starting Procedure

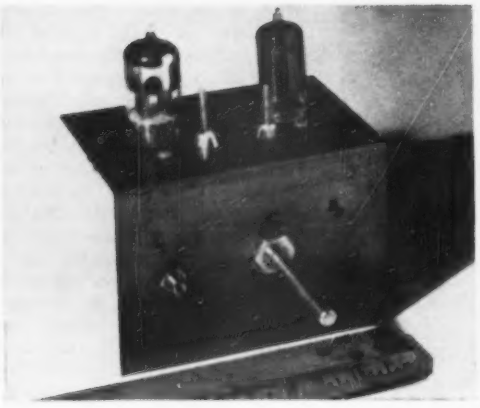
Before the start of calibration the master oscillator is set to approximately 20 kc below the first mark on its scale. The oscillator under test is set to a point still lower in frequency. The low-inertia motor M_2 is then connected to the output of the power amplifier and calibration is started by operating M_1 from the a-c line in a direction to increase the frequency of the oscillator under test. As this frequency rises and passes the frequency of the master oscillator, the output of the modulator passes through zero and rises toward 60 cycles. Motor M_2 picks up speed until the master-oscillator frequency settles down at 60 cycles lower than the test oscillator. This usually takes place well before the first scale mark of 50 kc is reached.

In case of any trouble which might prevent the master oscillator from overtaking the test oscillator the modulator output frequency would continue to rise. Since M_2 will not operate at high frequencies, a low-pass filter with a cutoff at 200 cycles is inserted in the modulator output circuit. If the frequency rises beyond this value, a relay operates to cut off power to both motors and the projection lamp behind the master film. The test oscillator is then run to a frequency lower than the master and started up as before.

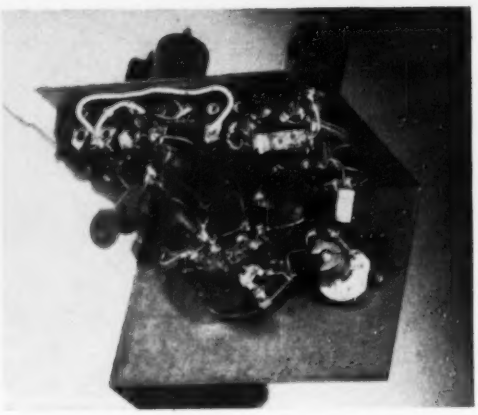
Checking Calibration

After development of the film two check frequencies are marked on the negative at 84 kc and 2,000 kc by comparison with standard frequencies. The 60-cycle scale displacement is compensated for by shifting the fixed oscillator frequency from the 84 kc and 2,000-kc check points during the initial line-up.

Early models of the test oscillator were hand-calibrated in a temperature-controlled room to avoid frequency drift. When done at ordinary room temperatures a realignment at the two check frequencies was necessary after every fiftieth mark to compensate for drift. In the automatic method the period of calibration is so short that frequency drift is negligible provided the test set and standard oscillator are not subject to severe drafts or wide changes in temperature in the room where the calibrating process takes place.



Complete all-channel tuner, whose circuit is shown in Fig. 48. Tunable coils are in the high-band coupling circuit



Exposed chassis view of tuner at left. Components that look like resistors are IRC fixed-tuned coils

BROAD-BAND

By choosing an i-f above 30 mc, so the image spectrum falls outside the television bands, it is possible to design a low-noise television front end with a broad-band r-f stage, and accomplish station selection by tuning local oscillator only. Selectivity of i-f eliminates adjacent-channel interference

By ARNOLD NEWTON
Consulting Engineer
Brooklyn, New York

THE TELEVISION front end selectivity requirements depend largely on the nature and intensity of the sources of interference in the image spectrums. If an i-f in the 41 to 47 region is chosen, the image spectrum falls well outside the television bands, and it should be possible to devise a selective r-f circuit broad enough to pass all the channels within one band, yet having sufficient selectivity to reject effectively all image signals. With proper design, the i-f selectivity can be relied upon for adjacent-channel rejection.

By eliminating the need for selective r-f tuning, station selection can be accomplished by tuning the oscillator.

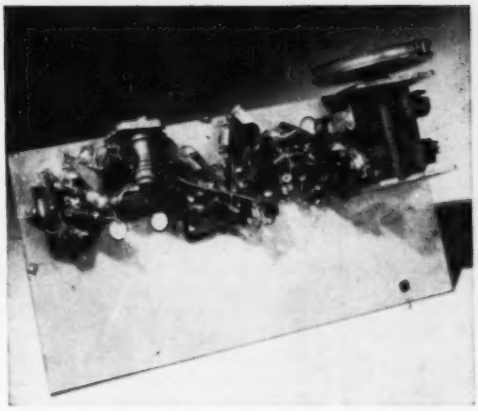
Since the bandwidth required of the r-f stage in such a system is six or seven times that assigned to one channel, a proportional reduction in gain would be expected. Fortunately, however, the improvement in the figure of merit as a result of eliminating the switch and other incidental capacitances makes it feasible to obtain gains which compare favorably with those of switch narrow-band circuits using similar tubes. Also, because only a fraction of the passband is being used at any one time, further increase in gain can be realized by reducing the damping from its critical value, without appreciably deteriorating the resolution.

The antenna and input r-f stage set the ultimate limit of a useful receiver sensitivity. A yardstick of the quality of the r-f stage is its noise figure which is defined as the ratio of the stage's actual noise power output to the noise power output due to antenna thermal agitation noise of an amplifier of identical bandwidth and gain, but introducing no noise of its own.

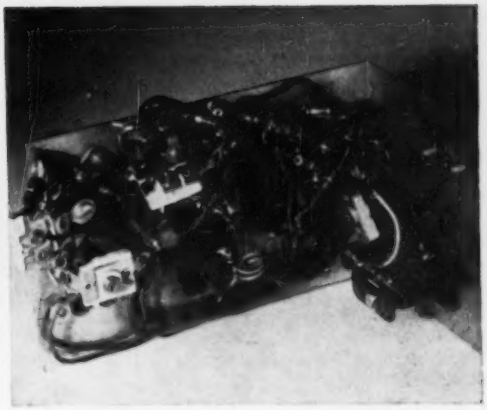
The overall noise figure of a multistage network can be determined by considering the noise contributed by individual stages and the gain of any preceding stages. It can be shown that if the stages have even moderate gains, the noise figures beyond the first stage or the first two stages may be neglected with negligible error.

Circuit Considerations

In order to evaluate different circuits for possible application to broad-band television front ends, the available gains and noise figures of the various configurations must be studied. In the following examples, R_{eq} is the resistance which would give rise to the same



Coils and trimmers between sockets are part of low-band bridged-T coupling network. Circuit for chassis shown is Fig. 4A



Broad-band tuner employing cascode r-f amplifiers, one for each band. Figure 4C shows circuit details

TELEVISION TUNERS

noise output power if introduced in series with the grid of an amplifier identical to the one under consideration, but noise free.

Grounded Cathode. Figure 1A shows the basic grounded-cathode circuit. Its noise figure can be determined by the formula

$$F = 1 + \frac{R_g}{R_i} + \frac{R_{eq}}{R_g}\left(1 + \frac{R_g}{R_i}\right)^2$$

It is seen to depend on the input resistance R_i whose value is set either by bandwidth or input conductance considerations, and R_{eq} of the tube. Under conditions of match, the noise figure is $2 + 4\,R_{eq}/R_i$.

Theoretically, these formulas apply for both triodes and pentodes. However, with triodes (which are more desirable by virtue of their low R_{eq}) the qualifying condition is stability. Neutralized single-ended triodes are critical in adjustment, especially over a wide band. Push-pull triodes are neutralized more easily but contribute twice the noise of a single tube.

Grounded Grid. The grounded-grid amplifier, shown in Fig. 1B is degenerative with the feedback voltage developed across the generator impedance due to the flow of plate current. The noise figure is

$$F = 1 + \frac{R_g}{R_i} + \left(\frac{\mu}{\mu + 1}\right)^2 \frac{R_{eq}}{R_g}\left(1 + \frac{R_g}{R_i}\right)^2$$

When μ is much greater than unity, as it is in practice, this expression becomes identical to the grounded-cathode expression.

Since the plate current flows through the generator, the tube presents a cathode impedance

$$\frac{e_{kg}}{i_P} = \frac{R_P + R_L}{\mu + 1}$$

Assuming $R_i \gg R_g$, $R_P \gg R_L$, and $\mu \gg 1$, $R_g = 1/g_m$ for match. For a

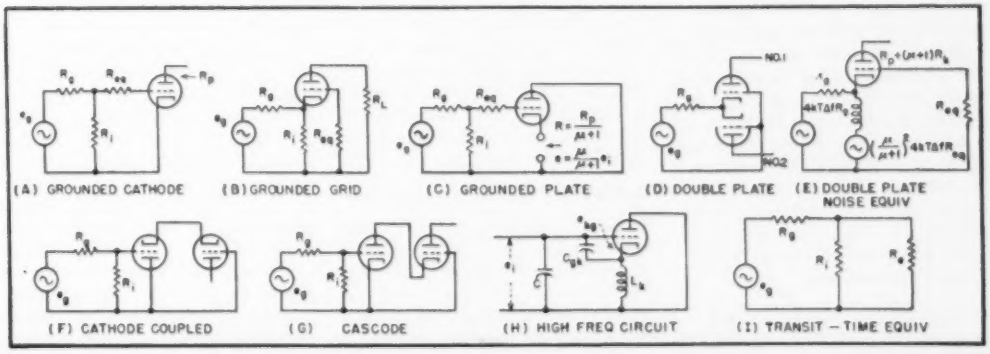


FIG. 1—Basic circuits considered in designing broad-band television front ends

triode $R_{eq} = 2.5/g_m$ and $F = 1 + R_{eq}/R_g = 3.5$. Then $F = 5.5$ db. The voltage gain of a grounded-grid stage is $\frac{1}{2}\ g_m R_L$ under the above assumptions.

Grounded Plate. The noise figure of a grounded plate amplifier or cathode-follower is the same as that of a grounded cathode amplifier.

Because of its lower gain and regenerative tendencies, depending on the nature of the cathode impedance, this circuit has found limited application. Certain variations are useful, however, in double-triode circuit arrangements which will be discussed later.

Double-Plate Grounded-Grid. Before proceeding with the discussion of the other possible combinations of the three basic circuits outlined above, the noise figure of the circuit shown in Fig. 1D will be considered. This circuit offers an easy way of separating the two television bands. The common cathode is the input terminal for all the channels and the plates pass the two bands respectively. Figure 1E shows the equivalent noise circuit of each triode section. The two triodes are assumed identical and the alternate load impedances are assumed small in comparison with the plate resistance at the respective operating frequencies.

Assuming $\mu \gg 1$, and matching the generator by the dynamic tube input conductance, the noise figure is 11.3 db. This circuit is inferior, from a noise figure standpoint, to other triode configurations, but has many practical advantages in its favor.

Cathode-Coupled Triode. The cathode-coupled amplifier combines the qualities of high input impedance and high gain and essentially the favorable noise figure of a single grounded-grid triode. Referring to the circuit of Fig. 1F, it is assumed that the two triodes are identical and the input resistance of the second tube is high in comparison with equivalent cathode impedance of the preceding stage. Using the nomenclature adopted in the previous analysis,

$$F = 1 + \frac{R_g}{R_s} + 2\,\frac{R_{eq}}{R_g}\left(1 + \frac{R_g}{R_s}\right)^2$$

Under conditions of impedance match $F = 2 + 8\,R_{eq}/R_g$.

There is a decided advantage in using this circuit if R_g can be made high.

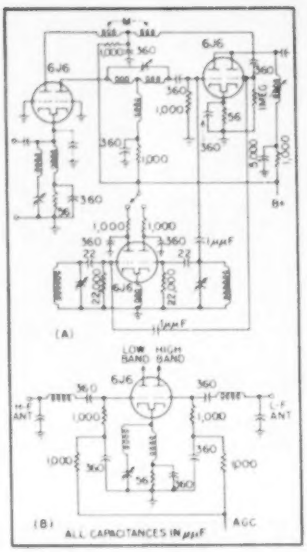


FIG. 2—Common-cathode circuit is antiresonant to frequencies in both television bands but series resonant to i-m band signals

Cascode. The cascode circuit represents another step in the direction of low-noise—high-gain r-f amplifiers. Its circuit diagram is shown in Fig. 1G. Again assuming identical triodes, no cathode resistance, and $\mu \gg 1$,

$$F = 1 + \frac{R_s}{R_g} + \frac{R_{eq}}{R_g}\left(1 + \frac{R_g}{R_i}\right)^2 \left(1 + \frac{1}{\mu^2}\right)$$

Under conditions of match and $\mu^2 \gg 1$, $F = 2 + 4\,R_{eq}/R_g$. The noise figure is better than that of the cathode-couple arrangement, and the gain is higher by 6 db since the voltage gain of the first stage is unity and not one-half as in the cathode-coupled circuit.

Considerations Above 100 MC

Above 100 mc the cathode inductance becomes an important factor in determining the input loading. The input conductance varies directly as frequency squared. Within the range of frequencies where $(g_m \omega L_s)^2 \ll 1$ (Fig. 1H) the input admittance is made up of the capacitance $C + C_{gs}$ shunted by a resistance $1/g_m\ (f_o/f)^2$, where f is the operating frequency and f_o the resonance frequency of the cathode inductance and the grid-to-cathode capacitance.

Another source of loading is the electronic input conductance due to the finite transit time in the cathode to grid space. The input resistance due to transit time is $R_e = 20/g_m(\omega\tau)^2$, where τ is the transit time, and R_e is the damping effect on the circuit. The noise contribution of R_e is greater than that of an equal external resistance by the ratio of the equivalent tube temperature to room temperature. It is necessary, therefore, to separate R_e from other input resistors. The noise figure of the input circuit in Fig. 1I is

$$F = 1 + \frac{R_{eq}}{R_i} + \frac{T_1}{T}\,\frac{R_s}{R_g}$$

The noise figure of a tube and its input circuit is

$$F = 1 + \frac{R_{eq}}{R_i} + \frac{T_1}{T}\,\frac{R_g}{R_s} + \frac{R_{eq}}{R_i}\left(1 + \frac{R_s}{R} + \frac{R_g}{R_s}\right)^2$$

When the ratio of $T_1/T = 5$ is used, account is taken of the induced noise. This noise component being due to the induced noise voltage in the grid when the grid-to-cathode transit angle is not negligible. It is directly related to R_{eq} and measurements have shown that the choice of $T_1/T = 5$ gives reasonably accurate results.

Antenna Transformers

The design of the input transformer is predicated by the conditions of match and bandwidth. A single-tuned transformer can be used by tapping on either the inductance or capacitance. The split-capacitance form is simpler physically and easier to adjust, but it must be remembered that by its very nature it is also a low-pass filter and sufficient low-frequency selectivity must be secured elsewhere.

The signal plate current is directly related to the available antenna power and inversely related to the product of the bandwidth and input capacitance. If e and r are

the antenna signal voltage and antenna radiation resistance respectively, then

$$i_p = \sqrt{\frac{e^2}{4r}} \frac{g_m}{\sqrt{\pi \Delta F C_t}}$$

Interstage Coupling

Selectivity and figure of merit are the major considerations in the design of the coupling network from the r-f amplifier to the mixer. The response to the image frequency divided by the response to the signal frequency is given as approximately equal to $\Delta f/4f_s$ for a single-tuned circuit and $2(\Delta f/4f_s)^2$ for a double-tuned circuit. In the high band where the sources of image interference are not particularly powerful the mean rejection figure of 5 obtainable with a double-tuned circuit, will be found sufficient, especially when an equal amount of selectivity is secured in the input transformer. A higher degree of selectivity is desirable in the lower frequency band. The lower-skirt selectivity should be high by reasons of i-f rejection and the upper-skirt selectivity should be high enough to reject the image signals. A simple network offering a high degree of selectivity and rejection of selected frequencies outside the passband is the bridged-T.

The need for selectivity not being as great at the higher frequency band, the use of simple circuits is desirable to assure uniform results with the small tuning elements employed. Stagger-tuning offers similar selectivity characteristics with greater simplicity of construction and tuning at some loss of gain.

When the input and output capacitances are lumped, the tuning inductances at the upper frequency channels generally become so small as not to lend themselves to normal tuning methods. To increase the tuning inductance the series instead of parallel arrangement of the output and input capacitances may be used for tuning. The gain and bandwidth product in this case remains the same.

Inasmuch as the r-f amplifier in its wide-band application offers comparatively lower gain the noise properties of the mixer stage cannot be completely disregarded in evaluating the overall noise figure. By this token it is desirable to use a low noise-contributing tube such as a triode. However, due to its high grid-to-plate capacitance care must be exercised in its use both at the low and high bands. At the low band the i-f is close to the r-f passband and it may, therefore, be necessary to include an i-f series-resonant trap in the grid of the mixer depending on the selectivity. At the high band, resonance within the r-f passband of the inductances inherent in the coupling capacitor and elsewhere in the mixer plate circuit should be avoided.

Practical Circuits

The simplest, although from a noise-figure standpoint least satisfactory circuit, is shown in Fig. 2A. Two sections of a 6J6 are used as grounded-grid amplifiers, one for the low and one for the high band. The input matches either a 100-ohm unbalanced line or with the additions of a balun transformer can be made to match a 300-ohm balanced line. The network in the cathode has two frequencies of antiresonance, one in the mid-band of the low and one in the mid-band of the high channels and is series resonant in the f-m band. This aids in matching the line and offers rejection of f-m interference.

The plate circuit of the low-channel amplifier employs a bridged-T as the coupling network to the mixer tuned to reject the i-f. A double-tuned circuit is used to couple the high-band amplifier. The two amplifiers couple into the respective grids of the 6J6 mixer, the plates of which are connected in parallel. By this device there is no need to switch any r-f circuits. Two Colpitts oscillators for the respective bands are used, only one being operative at a time. The bands are switched by switching the B+ voltage to the appropriate triode section of the 6J6 oscillator.

The next circuit to be discussed was proposed but not actually tested. It is identical to the circuit just described except for the r-f stage. It uses a 6J6 in what is essentially a reflex cathode-coupled amplifier.

It is assumed that in either band the tuning elements of the other band bypass the appropriate tube elements. This circuit still retains the basic simplicity of the first, but offers a better noise figure by virtue of the higher impedance at the grid input. The r-f amplifier section is shown in Fig. 2B. There are two inputs available which may be combined by using a proper dividing network.

The circuit of Fig. 3 was considered to exhaust the possibilities of this scheme. It uses four 12AT7 double triodes, one in a cascade circuit for each of the channels and two as oscillator-mixer combinations. Band switching is accomplished by switching the transmission line to the alternate inputs as well as switching the B+ to the oscillators.

Double-tuned input transformers

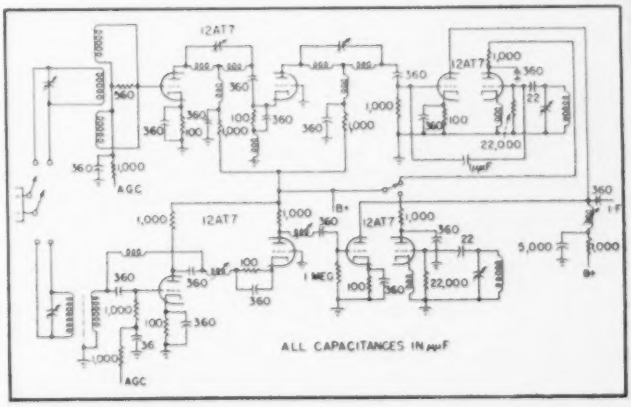


FIG. 3—Broad-band cascode circuits are used, one for each band. Band changing is accomplished by switching B+ and antenna transmission line

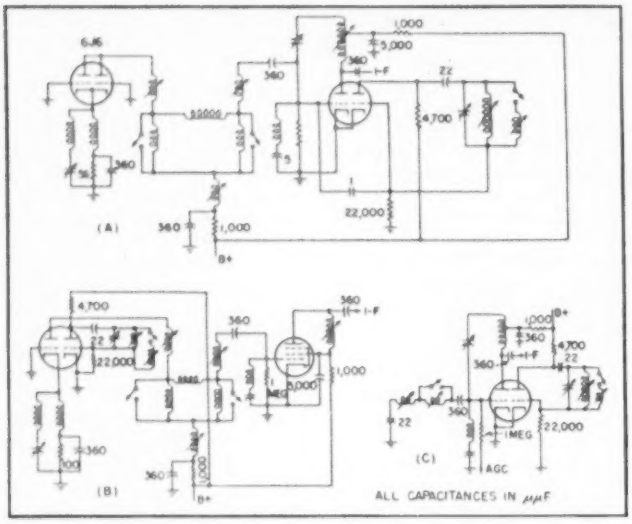


FIG. 4—Greater economy can be realized by these circuits without sacrificing performance. Figure 4C is a complete single-tube tuner with good noise figure. Oscillator radiation troubles can be eliminated by choice of i-f in 40 to 50-mc region

designed to match a 300-ohm line over a pass band of 40 mc are used. Two bridged-T networks are used in the low-band amplifier, the one designed to reject the i-f couples to the mixer and the other designed to reject the f-m couples the plate to the cathode of the cascode. The high band employs a staggered pair in its coupling networks and an inductance is added to tune out the grid-to-plate capacitance. In the low-band amplifier the improvement resulting from tuning out the grid-to-plate capacitance was not enough to warrant the addition of another tuning element. The inductances in the staggered pair, the primary antenna transformer capacitances and the bridged-T trap capacitors were made tunable; all other elements are fixed-tuned. This was found particularly justifiable in the low-band amplifiers where the Q is low (about 2).

By using one section of the tube as an oscillator and the other section in the same envelope as the associated mixer, more favorable and uniform injection of oscillator voltage was obtained. Little detuning was caused by the application of agc.

The common feature of all the circuits described thus far is that band switching is accomplished by applying B+ to the tubes chosen for the selected band, and in one case by switching also the antenna cable at a low r-f impedance level. By dispensing with switching of the r-f coupling circuits it was felt that a higher figure of merit would be realized as a result of eliminating switch capacitances. However, only half of the tubes are used at any particular time. More efficient operation may be secured by switching the r-f coupling circuit. With proper care the figure of merit at the high band need not be compromised and only a slight reduction would be suffered in the low band.

Greater Economy

To meet the need of greater economy, the circuit shown in Fig. 4A was devised. In it, the first 6J6 functions as a grounded-grid r-f amplifier. The cathode network is the same as in Fig. 2, being antiresonant within the two television bands and resonant with the the f-m band. The high-band r-f coupling network is not switched and hence the switch capacitance does not affect it. The low-band circuit appears in series with that of the high band and is switched. The switch introduces an additional 1.5 to 2 $\mu\mu$f of capacitance into the low band-pass filter. Double-tuned inductively-coupled circuits are used for interstage coupling. To suppress the response to image and i-f signals, series-resonant traps are included. The series-resonant filter in the grid of the mixer is tuned to the i-f. In addition to providing the necessary i-f rejection, the mixer grid impedance is also reduced, making it less subject to regeneration. However, in spite of the low grid impedance to the i-f, it was found necessary to neutralize the mixer.

In order to avoid the need for neutralization which calls for an additional tuning adjustment, a pentode mixer may be employed in a circuit shown in Fig. 4B. Here the r-f amplifier and oscillator are combined calling for a double triode with individual cathodes. Oscillator radiation under these conditions is higher and the gain and noise figure is less favorable. Figure 4C shows a tuner comprising a single dual triode, one section being used as an oscillator and the other as a mixer. In spite of the lack of r-f gain preceding the mixer, a good noise figure can be obtained by virtue of the fact that the grid impedance of the triode mixer is high. The main weakness of this circuit is the prohibitive amount of oscillator radiation which is likely to result. This difficulty can be eliminated to some extent by the choice of an i-f in the 40 to 50-mc region which will place the oscillator frequencies outside the tv bands. The choice of a higher i-f, however, will make neutralization more critical and lower the i-f rejection ratio.

The writer wishes to express his grateful acknowledgement to Leo Dwork, Paul Neuwirth and Robert S. Mautner for their valuable contributions to and assistance in preparation of this paper.

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GAMMA-RAY RADIATION MONITOR

Essentially self-switching over a voltage range of 100,000 to 1, this radiation measuring instrument is based on a scintillation counter. The wide range is accommodated by feeding amplified output of a comparison circuit to a servo motor turning a nonlinear potentiometer shaft geared to an indicator pointer

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THE GAMMA RAYS (high-energy x-rays) which are often associated with the experiments and apparatus of nuclear physics represent a danger to personnel. In addition, the constantly increasing use of gamma-active isotopes and other high-intensity sources of penetrating radiation in industrial applications has made it imperative that instruments be developed capable of detecting the danger and measuring its degree.

Various gamma-ray detectors have long been employed by physicists in actual experiments, but only recently have such detectors been applied to the problems of health physics. These detectors, in the usual experiments of nuclear physics, are pushed to the limit of their sensitivity. However, as health monitors they are called upon to operate in intense gamma-ray fields since a human being can tolerate considerable bombardment.

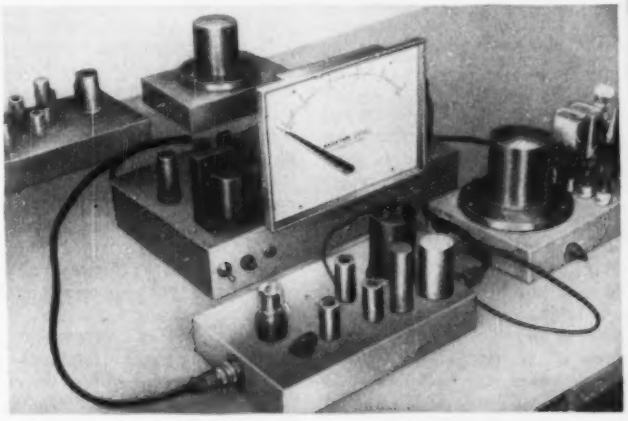
The commonly accepted tolerance dose for a full working day is 0.1 roentgen but this may soon be revised downward. A roentgen is that quantity of gamma radiation which will release (by ionization) 1 esu of charge in one cubic centimeter of air under standard conditions. Since the roentgen is a total quantity of radiation, the tolerance dose may be absorbed in a short time at high intensity or over a full day at reduced intensity. For this reason it is necessary that any dosage rate metering device cover a very wide range of intensities.

Ideally, the instrument should be capable of accurately measuring rates of from 1 milliroentgen per hour to approximately 100 roentgens per hour without manual range switching or attention of any sort. This represents a dosage scale extending over five decades, and corresponds to tolerance working periods of no limit to 4 seconds per day. For a full ten-hour day the maximum average rate would be 10 milliroentgens per hour. It should be stated here that the precision of measurement required for dosages is of the order of 15 percent because of the wide variation in specific radiation effect with irradiated personnel, and the roughness of the data used to set the tolerance level.

There are at least three gamma-ray detectors which are theoretically operable over the required intensity range. These are the Geiger-Muller counter, the ionization chamber and the recently rediscovered scintillation counter.

The Geiger-Muller counter, probably the most convenient and widely used gamma-ray detector at present, is limited to relatively low intensity measurements (low counting rates) because of a 100 to 200-microsecond dead time exhibited by the device after each count. It would thus be difficult to use in radiation fields of the order of roentgens per hour.

Recently some work has been done with G-M counters in which they are used at very high counting rates with the aid of high sensitiv-



Complete radiation instrument consists of servo preamplifier, foreground; probe pick-up and power supply, right; indicator unit, center; dark-current cancellation chassis, and a spare probe unit, background

ity pulse-recording circuits.

The ionization chamber suffers no such high-intensity limitation if a sufficiently large collecting voltage is used. However, the chamber is a high-impedance device which makes the highly desirable feature of automatic range switching difficult to obtain.

Basic Principle

The instrument to be described uses a scintillation counter detector, the choice of which was dictated by the fact that it is a reasonably low-impedance device and is not troubled by saturation effects at high radiation levels.

This is evident from the mechanism whereby the gamma ray is detected in a scintillation counter. The incident gamma collides with an electron in a crystal and gives up a portion of its energy by the Compton process. The recoil electron, in turn, imparts its energy to the crystal which dissipates the energy by fluorescence, thus producing a flash of light or scintillation which is viewed by a photomultiplier tube. Many such happenings may occur simultaneously, permitting very high counting rates.

For monoenergic gamma rays the light output of the crystal is directly proportional to the intensity of the radiation or dosage rate. The d-c photomultiplier current is, therefore, a measure of the radiation dosage rate. Proper operation of a scintillation detector over a range of 100,000 in intensity is readily obtained by judicious choice of the photomultiplier's operating point.

The detector consists of an anthracene crystal $1 \times 1 \times 0.5$ cm and a type 931A photomultiplier tube. The output of the tube is integrated to provide a d-c level proportional to the pulse rate, and is compared to a balancing voltage. Any difference between the comparison voltage and tube output is amplified and used to position a servo motor on a highly nonlinear potentiometer geared to an indicator pointer. The range of photomultiplier output voltage which may be balanced is 100,000 to 1 because of the special potentiometer used.

The criterion for selection of the photomultipliers is low absolute dark current, which, however, is not a difficult requirement to meet since the dark current of all the tubes checked was in the vicinity of 1.0×10^{-8} ampere. The photomultipliers used in the instrument are operated in the vicinity of 900 volts, which must be well stabilized. Since multiple probes are sometimes used with the same indicator, the sensitivities of the tubes are matched by adjusting the voltages on the first two stages.

The crystal is mounted on the phototube and the entire assembly placed in a cylindrical brass housing, which in turn is mounted on a probe chassis and gasketed for light tightness. A serious problem is the electrical leakage across the socket of the tube. The entire base assembly is, therefore, thoroughly cleaned and coated with paraffin. This procedure reduces the no-signal output of the tube by at least a factor of 10.

Circuit Details

The load resistor of the photomultiplier drives an R-C low-pass filter which serves to eliminate the rapidly varying components of the phototube output so the servo system will not act erratically. This R-C integrator circuit serves the second important function of slowing down any step-function increase in radiation level (and multiplier output) which could block the servo amplifier.

The d-c output signal of the integrator circuit is fed to a Brown Instrument Co. converter along with a d-c comparison voltage supplied from the servo-driven slidewire. Since the impedance level at the converter is of the order of one megohm and the applied signal is of the order of 0.1 millivolt at the low end of the range, considerable hum is introduced by the vibrator driving coil. This hum pickup is greatly reduced by opening the converter and rearranging the driving coil leads so that they come out the top of the housing.

The converter, essentially a driven single-pole double-throw switch, is designed so that the contactor arm closes each of the two circuits some 45 degrees of a complete cycle, and shorts both circuits together for about 10 percent of a cycle. This action permits the integrating capacitor C to receive charge via the low-impedance comparison voltage circuit. The capacitor holds this charge easily until the contactor closes the tube circuit, and thus the net voltage change as seen by the first amplifier grid is very nearly zero. To prevent this action, a resistor R is placed in series with the comparison voltage such that the integrating capacitor takes on very little charge from the comparison voltage.

The 60-cycle unbalance voltage derived from the converter is fed to the grid of the first servo preamplifier tube. It was found convenient to heat the filament of this tube by r-f power supplied by a simple tickler oscillator to reduce the 60-cycle pickup.

The circuit of the servo preamplifier consists of two 6AK5's and one 6SL7. This tube line-up yields a gain of the order of 10^6 if the amplifier is linear. The preamplifier is R-C-coupled to two 6N7's which serve as the servo power amplifier.

Special Potentiometer

The servo motor is used to drive the comparison-voltage potentiometer and the indicator needle. The system is geared so the motor, running at 160 rpm, drives the potentiometer through 330 degrees and the needle through 110 degrees in approximately 10 seconds. Since the signal voltage available from the multiplier tube varies over five decades, it is also necessary that the comparison voltage do so. To accomplish this, the wire-wound potentiometer is tapped at four regularly-spaced intervals.

A one-ohm resistor is placed across the first interval, 10 ohms across the second, 100 ohms across the third, 1,000 ohms across the fourth, and no resistance across the last which is one-fifth of a 50,000-ohm potentiometer, or 10,000 ohms. When a voltage is applied across the potentiometer, one ten-thousandth appears across the first interval, one-thousandth across the second and so on. Thus, the ratio of voltages available from the potentiometer is 100,000 to 1 (ratio of voltage on one-tenth of the first decade to full pot voltage).

The total potentiometer voltage is adjusted so the 100 milliroentgen per hour level would fall at the end of the second decade. This adjustment is very stable and requires 21 volts across the entire potentiometer, or approximately 21 millivolts across the second decade.

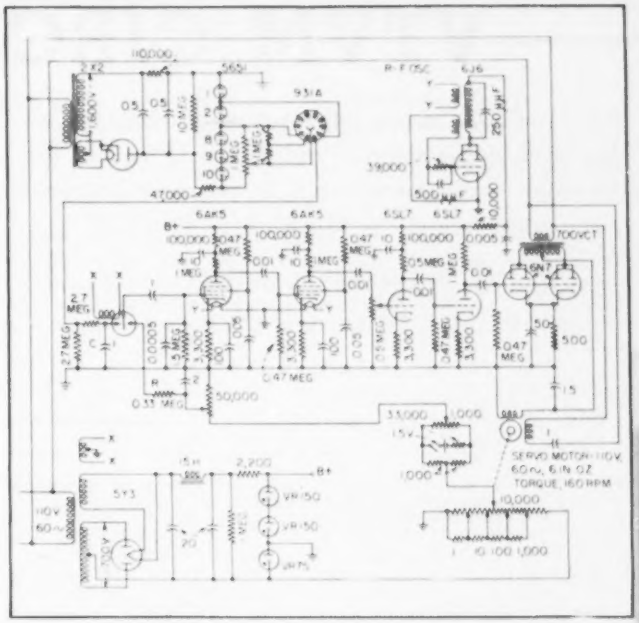
There are two basic limitations to the performance of the instrument. At very low levels (5 mr per hr or less) there are dark-current variations and at very high levels (10 r per hr or more) there is photomultiplier fatigue.

The dark current of the photomultiplier, due to thermionic emission from the photocathode, is strongly temperature-dependent and thus may cause a shift in the zero position of the instrument as the temperature varies. However, with tubes selected for low dark current, this effect is small enough to be neglected providing no levels less than 5.0 mr per hr need be measured to 15-percent accuracy. It was found that a 4-degree C change in temperature caused a shift of the order of 0.7 mr per hr.

For those applications requiring higher sensitivity and accuracy, at least two possibilities are open. First, a thermostatically controlled oven operating at about 40 C (to absorb maximum room temperature) has been used successfully. A Fenwal thermoswitch or similar device and resistor heating element will maintain the temperature to within 0.4 C and thus effect a considerable increase in the minimum measurable signal (at a given accuracy).

Second, a more direct method of cancelling the dark-current pulses has been employed. It is found that the pulses making up the dark current of a photomultiplier tube are considerably smaller than the average current pulse due to a scintillation. This immediately suggests the use of a pulse-height discriminator circuit set to reject dark-current pulses.

However, any direct pulse-height discriminating circuit would become completely blocked at higher radiation levels, and its output would rapidly go to zero. It is thus necessary to employ a discriminator circuit in which blocking does not cause the entire instrument to become inoperative. (At levels which block the discriminator, dark current is unimportant.) This may be done by placing the discriminator circuit in a feedback loop circuit arrangement.



Circuit of gamma-ray radiation monitor. Contacts of the converter are shown in circle at left center

The voltage on the integrating capacitor is thus due only to those portions of the input pulses which are above the discrimination level. This eliminates the dark-current pulses entirely, at the expense of a factor of three in sensitivity which may be made up elsewhere in the instrument.

If the radiation monitor were required to operate over very wide temperature ranges at high sensitivity, it would probably be necessary to combine pulse cancellation and thermostatic control, since there is evidence that the light output of the crystal itself varies somewhat with temperature.

Photomultiplier tubes, when operated at high light levels, exhibit a fatigue effect wherein the output current decreases steadily with time although the illumination is constant.

At low levels of illumination, the recovery per unit time approaches the fatigue rate and the net loss in sensitivity is small. It is thus important to keep the photomultiplier output as small as possible at high radiation levels. In a reasonably good tube, the fatigue is considerably less than 5 percent at a current of 30 microamperes. It is good design to minimize the tube output and maximize the servo system sensitivity. For this reason, the anthracene crystals need not be large, or backed by a reflecting surface. Since the instrument is designed for approximately 30 microamperes of multiplier tube current at 100 r per hr, the minimum current is of the order of 3×10^{-9} ampere (or about one-third of the dark current of the tube). It is, therefore, desirable that tubes be selected for low absolute current.

In certain installations, there is the possibility of cooling the tube to reduce dark current, and at the same time maintain a constant temperature. This technique is not without possible drawbacks, however, since there is some evidence to indicate that fatigue effects are greatly increased at lower temperature.

VTVM CIRCUITS

Survey of basic vacuum-tube voltmeter circuits, including pertinent equations, evaluation of circuit performance and accuracy, and frequency and voltage range limitations of each type of circuit

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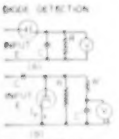
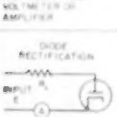
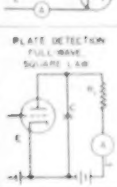
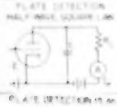
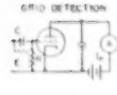
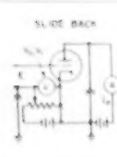
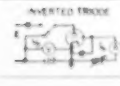
THE ACCOMPANYING TABLE lists the major functional characteristics of eight fundamentally different detecting circuit elements of vacuum-tube voltmeters.

The major performance desiderata of a vacuum-tube voltmeter for frequencies up to several hundred megacycles are: (1) low-input capacitance; (2) high-input resistance; (3) short internal leads to

Circuit	Principle of Operation	Basic Formulas	Input Impedance
	C charges to E_{PEAK}. R acts to discharge C. In (B), R' and C' act as a filter to keep r-f out of d-c measuring circuit	For linear diode characteristics, $V_{d.c.} = KE_{PEAK}$ $R_{EQ} = \frac{R}{2I_PRE_{PEAK}} = \frac{R}{2\eta}$ η = rectification efficiency = unity (approx.) as R and E increase. For square-law diode, η is function of E	Equivalent of 1 to 25 megohms shunted with 3 to 10 $\mu\mu$f; 10^6 ohms at 300 mc is possible. In general, is function of R and E. At one value of R, input impedance is practically independent of E
	$R_P = 0$ by assumption $I_{P_0} = 0$ by assumption R_LI_{AV} = average voltage of the positive half-cycle	For a sinusoidal input $I_P = \frac{E_{MAX}}{\pi R_L}$	$2R_L$
	Approximate parabolic lower curved portion of I_P-E_C characteristic is used. Average plate current is higher than the quiescent plate current. Biased for $i_P > 0$ throughout the cycle. R_L is usually omitted	$\Delta I_P \cong K(E_1^2 + E_2^2 + E_3^2 + \ldots)$ to a first approximation. $\Delta I_P = \frac{1}{4\mu g_{m0}(r_P + R_L)} \times \left(\frac{\partial r_m}{\partial E_0}\right)(E_1^2 + E_2^2 + E_3^2 + \ldots)$	Approximately 10^7 ohms at frequencies up to few mc shunted by $(C_{GP} + C_{GC})$. May drop to 10^4 or 10^3 at 300 mc depending on tube. $R_G = \frac{1}{Kg_m f\tau^2}$ τ = electron transit time
	Same as above except that tube is biased to cutoff. For large R_L and $C = 0$, i_P is nearly proportional to e_G during positive half-cycles	For relatively large values of R_L and E, $I_P \cong KE_{AV}$. For small r-f voltages and low values of R_L, $I_P \cong K(E_1^2 + E_2^2 + E_3^2 + \ldots)$	Same as above
	Tube is biased appreciably beyond cutoff	$I_P \cong KE_{PEAK}$	At negligible transit-time effect $R_G \cong K/f$ $C_G = (C_{GP} + C_{GC})$
	Operates on lower curved portion of grid-current grid-voltage curve and straight or curved portions of I_P-E_G characteristic. $X_C << R$	$\Delta I_P = g_mR\Delta I_G$ over linear portion of I_P-E_G characteristic	Relatively low
	D-C bias adjusted to obtain same plate current with and without r-f input. $I_P = I_{P_0}$ = few μa	Peak of positive half-cycle = E_{MAX} = $K(V_1 - V_0)$. K approaches unity as E increases and as sharpness of cutoff increases. May be as low as 0.2 depending on tube characteristics and E. V_0 = d-c voltage at $E = 0$. V_1 = d-c voltages at other values of E	$\frac{1}{\omega(C_{GP} + C_{GC})}$ Input resistance is approaching leakage resistance across input terminals
	I_G is reduced when r-f voltage is applied at input. V_P is negative	$E_{PEAK} \cong V_P$ required to produce same I_G. Amplification factor $\cong \frac{1}{\mu}$	Resistance is of order of 1,000 megohms shunted by $C_{CP} + C_{PG}$

terminals; (4) high series-resonance frequency of input-lead inductance and capacitance; (5) freedom from transit-time error; (6) maximum voltage range with minimum auxiliary equipment such as amplifiers and voltage dividers; (7) peak voltage calibration for nonsinusoidal waves and rms for sinusoidal waves; (8) linear scale or large number of overlapping scales for square-law indications; (9) negligible zero drift and steady indication; (10) calibration corrections must not be affected by ordinary line-voltage variations, aging and temperature and humidity changes, must remain reasonably constant and must not be affected by tube replacements; (11) v-t voltmeters must not generate disturbing voltages.

Associated circuits, such as amplifiers, current-balancing circuits and voltage dividers, are equally important in determining sensitivity, linearity, and range of the vtvm.

The table and text are excerpts from NBS circular 481, *High-Frequency Measurements*, by Myron C. Selby, published by the Department of Commerce and available from the Superintendent of Documents, U. S. Government Printing Office.

Output and Waveform Effect	Voltage Range	Frequency Range and Error	Calibration Stability	Remarks
Source impedance must be negligible at all harmonics, and level of harmonics must be low, otherwise error may be as large as percentage harmonics present Output = E_{PEAK}	The upper limit depends on tube rating. With a sensitive d-c voltmeter or a d-c amplifier, the lower limit is a fraction of a volt	Upper limit is affected by series resonance of input L and C, anode to cathode r-f voltages and transit-time error. Range is function of voltage applied. Correction curves may be used to extend range	Good. Depends on constancy of filament voltage and emission. May require yearly calibration	This circuit followed by a self-biasing d-c amplifier seems most suitable for the widest frequency range. To eliminate low-frequency discrimination, the RC constant should be at least 100 at lowest frequency. Input series resonance increases apparent input voltage at fundamental and emphasizes harmonics more than fundamental
No error caused by reversing input, even with unsymmetrical waveform. Output = E_{AV}	Fraction of volt to few hundred volts, depending on R_L and tube rating	Should be calibrated at operating frequency above 1 mc. Probable range up to several mc	Same	R_L may vary from 0 to 1 megohm. For R_L > 100,000, error caused by slight curvature of static tube characteristic is negligible
ΔI_P depends somewhat on waveform. Theoretically there is no turnover. Phase of harmonic has no effect. Output = $(E_1^2 + E_2^2 + E_3^2 + \ldots)$	Fraction of volt to top limit within square-law range of tube (a few volts for commercial tubes)	With commercial tubes, low-frequency calibration will hold within 5 or 10 percent to 20 or 30 mc. At higher frequencies calibration at each frequency is necessary	Poor, as a result of tube aging and variations in d-c voltages	Noise output can be corrected for by subtracting it from total output. That is, $\Delta I_s = \Delta I_{TOTAL} - \Delta I_{NOISE}$
Subject to turnover and phase of harmonics. For output, see remarks	Fraction of volt to value of E causing grid current to flow	Same	Same	Output = E_{AV} if plate current characteristic is linear. = E_{rms} if plate current characteristic is parabolic
Subject to turnover and phase of harmonics (see remarks)	From $E_{MAX} \cong V_Q$ to values causing flow of grid currents	Same	Same	Not recommended. Error might be appreciable
Error may be appreciable (see remarks)	Fraction of volt to few volts with receiving type tubes	Approximately to 10 mc	Very poor	When plate rectification takes place in addition to grid rectification, ΔI_P may equal zero at certain level of E. Output = E_{rms} or E_{PEAK}, depending on input and operating voltages
Subject to turnover. Output = E_{PEAK} of positive half-cycle	Fraction of volt to few hundred volts. Calibration is indispensable especially below about 10 v. Calibration should be made for given I_P	Approximately to 10 or 20 mc, depending on input capacitance	Good. Practically independent of aging and operating voltage variations	Sharp cutoff is obtained with pentodes connected as triodes, with screen grid used as control element
Subject to turnover. Output = E_{PEAK}	Large voltages, depending on tube design	Possibly to 10 mc (see remarks)	Probably good. No experimental data available	Theoretically frequency range is limited by input capacitance. No experimental data available

The TRON Family

An alphabetical listing of over 200 words ending in the suffix *tron* is presented here, with definitions, to assist readers in avoiding duplication when a new product or firm name is under consideration.

By W. C. WHITE

Electronics Engineer
General Electric Research Laboratory
Schenectady, New York

Acratron Self-balancing a-c potentiometer-type electron recorder.
Actron Trade name for a group of manufactured devices.
Aerietron Trade name for a group of receiving tubes manufactured in early years of broadcasting.
Aletron Name of firm that designs and manufactures electronic and aircraft components.
Alphatron Trade name for an ionization gauge.
Amertron Trade name for products of a certain firm.
Aquatron Trade name for an electrolytic water purifier.
Arcotron German high-vacuum tube with external control electrode.
Arclitron Trade name for a British photographic flash lamp.
Argotron Trade name for a British stroboscopic discharge tube.
Aspatron British portable atomic pile.
Astron Name of a firm manufacturing capacitors.
Audiotron Trade name for a receiving tube sold in early 20's.
Augetron British high-vacuum multistage electron multiplier tube.
Autotron Trade name for a photoelectric control.
Axiotron High-vacuum thermionic-cathode diode. Magnetic field from filament controls the current.
Ballastron (1) Trade name for an iron wire in hydrogen ballast tube. (2) Trade name for a fluorescent lamp p-f improvement capacitor.
Barytron Same as **Mesotron**.
Betatron Apparatus for the production of very-high-speed electrons.
Bevatron High-energy proton accelerator. Similar to the **Cosmotron**.
Caltron Name of a firm manufacturing electrical specialties.
Calutron Electromagnetic type of uranium isotope mass separator.
Capacitron (1) glass mercury-pool tube in which the arc is started by an external electrode. (2) Multimillion-volt atom smasher. (3) Name of a firm manufacturing electrical components.
Cardiotron Trade name for an electrocardiograph.
Cathetron Same as **Kathetron**.
Cetron Trade name for a certain manufacturer's line of tubes.
Charactron Type of cathode-ray tube that displays a series of letters or numbers.
Chronotron (1) Trade name for a time-delay tube. (2) Apparatus for accurately measuring extremely short-time intervals.
Claroltron Trade name for an early line of radio receiving tubes.
Clectron Trade name for products of a certain firm.
Clinitron Equipment to check for the presence of diabetes.
Convectron Tube to indicate variations from a vertical position.
Cosmotron High-energy proton accelerator. Similar to a **Bevatron**.
Cyclelron British name for a form of **Cyclotron**.
Cyclotron Apparatus for producing a beam of high-velocity charged particles.
Dalmotron Trade name for products of a certain firm.
Detectron (1) Trade name for a line of early radio broadcasting tubes. (2) Japanese designation for certain vacuum tubes.
Diatron Trade name for a mass spectrometer.
Diotron An instrumentation circuit using a temperature-limited diode.
Donutron All-metal tunable magnetron.
Duodynatron Japanese dynatron tube in which the secondary electrons originate on a grid.
Duratron Trade name for a hearing aid.
Dynatron High-vacuum triode utilizing secondary emission.
Dynectron Form of commutator utilizing mercury in an evacuated envelope.
Dyotron Single-cavity three-electrode microwave oscillating tube.
Elastron Trade name for a plastic material.
Electron Elementary quantity of negative electricity.
Elechtron Trade name for a mineral product.
Eltron Name of a firm manufacturing electrical equipment.
Emitron British camera tube.
Ertron Pharmaceutical vitamin compound.
Estron Trade name for a synthetic fiber.
Excitron Form of mercury-arc rectifier with a holding anode.
Faratron Trade name of a device for controlling liquid levels.
Filtron Name of a firm manufacturing components.
Flashtron Sensitive gas-discharge relay.
Flexitron Trade name for an enlarging lens for tv receivers.
Frenotron British form of diode-triode combination.
Furnatron Trade name for an electronic furnace control.
Fusetron Trade name for products of a certain firm.
Gagetron Trade name for a liquid-level indicator.
Galvatron Trade name for a sensitive electrical recorder.
Gammatron Trade name for a line of vacuum tubes.
Gantron Trade name for a luminescent fabric.
Gasomagnetron Russian form of magnetron tube containing gas.
Gausitron Same as **Gusetron**.
Genetrons Trade name for a series of organic compounds.
Genotron Trade name for high-voltage rectifier tubes.
Germitron Trade name for an ultraviolet lamp unit.
Glastron Trade name for a fabric of woven spun glass.
Gusetron Mercury-arc rectifier tube with high-voltage starting electrode. Same as **Gausitron**.
Hartron Trade name for a tape-recording device.
Hodecetron Gas-content mercury-arc tube in which the arc is started by a magnetic pulse.
Hurletron Trade name for the products of a certain firm.
Hytron Trade name for a line of vacuum tubes.
Ignitron Mercury-arc tube containing an igniter to start arc.
Illitron Trade name for a high-frequency heating line.
Infratron Trade name for an electric space heater.
Instron Testing machine for testing tensile strength.
Ionotron Device using radioactive material to minimize troublesome electrostatic charges.
Isotron Device for the separation of uranium isotopes.
Kalistron Trade name for a plastic material.
Kallirotron British tube and circuit that act as an amplifier or oscillator.
Kathetron Trade name for glow-discharge triode. Same as **Cathetron**.
Kenopliotron Vacuum tube in which the cathode of the triode element is the anode of the diode element. This common element is heated by electron bombardment.
Kenotron High-vacuum thermionic-cathode diode.
Kevatron High-votage particle accelerator.
Kinetrons Trade name for certain cathode-ray tubes.

(continued on page 114)

STANDARD ASSEMBLIES

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The Tron Family (Continued from page 112)

Klystron High-vacuum multielectrode tube used for production and amplification of vhf.

Kodatron Gas-discharge flash lamp.

Kotron Trade name for a form of selenium rectifier.

Learitron Trade name for a phonograph pickup device.

Lectron Trade name for a solder.

Leatron Trade name for a pharmaceutical compound.

Limitron (1) Trade name for an electron comparator. (2) Trade name for products of a certain firm.

Lumetron Trade name for a colorimeter.

Lustron (1) Trade name for a plastic. (2) Trade name for a prefabricated home.

Luxtron Trade name for a photovoltaic cell.

Magnetron (1) High-vacuum thermionic-cathode diode in which current is controlled by variation of magnetic field. (2) Oscillating vacuum tube for production of vhf.

Maxitron Trade name for an x-ray tube.

Mercanitron Name of a firm and the trade name of its products.

Megatron Trade name for a disk-seal triode.

Meletron Trade name for a firm.

Merecron Trade name of a product made by a certain firm.

Mesotron A charged particle.

Metron Name of a firm.

Microtron Russian apparatus for the acceleration of electrons.

Minitron Trade name for small radio receiving tubes.

Monitron Instrument to detect harmful radiations.

Monotron (1) Trade name for monoscope tubes. Same as **Videotron**. (2) Form of **Klystron** (Russian).

Motron Trade name for equipment manufactured by a certain firm.

Multicardiotron Trade name for a product of a certain firm.

Musitron Name of a firm.

Negatron High-vacuum tube having a negative characteristic.

Neostron British stroboscopic tube.

Neotron (1) Gas-filled pulse generator tube. (2) French vacuum tube firm and its products.

Neptron Trade name for tubes made by a certain firm.

Neutron Uncharged particle.

Nimatron Automaton to play the ancient Chinese game of Nim.

Nitron Trade name for certain plastic products.

Nobatron Trade name for a d-c power pack.

Nutron (1) Trade name for an early line of radio receiving tubes. (2) Pharmaceutical compound.

Nylatron Trade name for a synthetic dry bearing material.

Omegatron A miniature cyclotron.

Optron Name of a firm and trade name of a product.

Organtron Name for an electronic organ.

Palletron Electron resonator for production of high potentials.

Penetron (1) Sometimes used to denote a **Mesotron**. (2) Device for measuring thickness.

Pentatron Five-electrode receiving tube.

Permatron Form of vacuum tube in which the current flow is initiated by a magnetic field.

Phanotron Hot-cathode gas-content diode.

Phantastron Controllable linear time-delay circuit.

Phasitron Type of beam deflection tube to produce f-m.

Philcotron Trade name for an electrolytic rectifier cell.

Phonotron Trade name for a line of early radio receiving tubes.

Photo-augetron British form of photocathode multiplier tube.

Pho Tron Name of a firm.

Phytotron Laboratory of botanical research.

Plastron Name of firm and its products in plastics field.

Pliodynatron Dynatron with a control grid added.

Pliotron High-vacuum thermionic-cathode tube.

Plomatron British name for a grid-controlled mercury-arc tube.

Polatron Trade name for a picture tube incorporating a neutral filter device.

Polectron Trade name for a group of dielectric materials.

Polytron Name suggested for a suspected elementary particle.

Positron Elementary particle.

Powertron Name of a firm dealing in electrical equipment.

Precipitron Trade name for an electrical precipitating device.

Prionotron Form of velocity-modulation tube.

Protectron Trade name for devices made by a certain firm.

Pulsatron Gas-filled tube utilized as a generator of pulses.

Pyrotron Trade name for temperature control apparatus.

Quadratron Four-element thermionic-cathode high-vacuum tube.

Radiotron Trade name for a line of radio tubes.

Ray-lectron Name of a firm selling radio devices.

Raytron Name of firm and product used for ground-fault location.

Reactron Trade name applied to some of the products of a certain firm.

Receptron Trade name applied to some of the products of a certain firm.

Rectron Trade name used for a line of tubes.

Remtron Form of discharge tube used in counters and computers.

Resnatron Same as **Resnotron**.

Resnotron High-power high-frequency tetrode of special design.

Rhumbatron Name given to the resonator cavity of early **Klystrons**.

Robotron Name of firm and its product in flashtube field.

Rotron (1) Trade name for an electronic telephone ringing device. (2) Name of a division of company making electronic devices.

Selectron (1) Trade name of a plastic material. (2) Form of memory tube.

Seletron Trade name for a line of selenium rectifiers.

Sendytron Japanese name for a mercury-arc tube having a high-voltage starting electrode.

Sensitron Trade name for some products of a certain firm.

Sentron Short-wave tube of Japanese design.

Servotron (1) British mercury-arc tube with a high-voltage starter. (2) Trade name for an electronic motor control.

Skiatron British device for television picture projection.

Soldetron Trade name of a certain firm's soldering iron.

Solotron Trade name for the products of a certain firm.

Sortron Part of a trade name for a firm's testing gage.

Spectron Name of a firm manufacturing glass parts.

Spirotron Device for decelerating high-speed particles.

Statitron Form of Van deGraaff high-voltage generator.

Stenotron Gas-filled transmitting tube of Russian design.

Stethertron Trade name for an electrical device.

Strobotron Glow-discharge tube used as a stroboscope.

Supertron Trade name for an early line of radio receiving tubes.

Symetron Multiple-tube ring-type amplifier for high frequencies.

Synchrocyclotron Particle accelerator.

Synchrotron Apparatus for producing beam of high-velocity particles.

Syntron Form of electric hammer.

Takktron High-voltage glow-discharge rectifier tube.

Tapestron Trade name for a plastic wall screen.

Tarrytron Trade name for a product of a certain company.

Telectron Name of a radio firm.

Teletron Trade name for a cathode-ray oscillograph tube.

Textron Name of company and its product in textile field.

Theatron Dramatic organization.

Thermatron Trade name for high-frequency heating equipment of a certain firm.

Thermotron Trade name for an early line of radio receiving tubes.

Thyratron Hot-cathode gas-discharge tube in which there are one or more control electrodes.

Tuccotron Trade name for division of a company and its products.

Transitron (1) Circuit incorporating a tetrode. (2) French equivalent of the transistor.

Trigatron (1) British triggered spark gap for radar pulsers. (2) Induction-heating device.

Trigenitron Trade name for a mercury-arc type of tube used in welding control.

Triotron Trade name for European line of radio tubes.

Trochotron High-vacuum multi-electrode tube for counting circuits.

Tropotron Form of magnetron.

Ultron Trade name for a plastic.

Unitron Trade name for a firm and its battery charger.

Vacutron Trade name for firm and its line of tubes.

Variotron Nom de plume of a British author in the radio field.

Varitron Trade name for a line of commercial cameras.

Vectron Name of a manufacturing firm.

Velocitron Form of mass spectrometer.

Veritron Trade name for an electronic pyrometer.

Vibratron Form of high-Q resonator.

Vibrotron Triode with a movable anode.

Victron Trade name for products of a certain firm.

Videotron See **Monotron** (1).

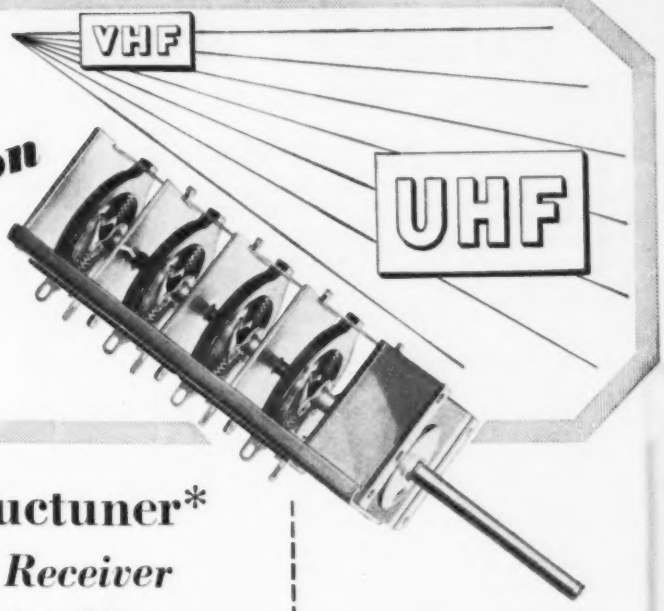
Visitron Trade name for a projection-type cathode-ray tube.

Vitron Plant food for garden use.

Voltron (1) Trade name for early line of radio receiving tubes. (2) Trade name for insulating compound.

Zyklotron Trade name for a Swiss high-frequency tube.

Value Beyond Specification



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An increasingly important consideration in the design of television receivers is the effectiveness with which they can later be coupled with a converter for UHF reception. Thorough analysis reveals that a front end unit built around a Mallory Inductuner provides flexibility and freedom from interference which are unequalled for this purpose by any other tuning device.

Because of the continuously variable inductance provided by the Inductuner, it is possible to select a conversion frequency that is most desirable from the standpoint of both harmonic and direct IF interference. Simply by the addition of a dial marking at the most desirable point in the unused frequency range between existing channels 6 and 7, the receiver manufacturer can prepare for later UHF conversion under ideal conditions.

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That's value beyond specification!

That's why the Inductuner has become the center of growing respect and interest throughout the industry. Your request for detailed technical data will be welcomed.

Outstanding Advantages of the new Mallory Spiral Inductuner:

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2. Easily adapted to UHF converter use.
3. Excellent stability eliminates frequency drift.
4. Supplied in three- or four-section designs.
5. Far more quiet operation; permits high signal-to-noise ratio in front end designs.
6. Free from microphonics.
7. Greater selectivity on high frequency channels.
8. Eliminates "bunching" of high band channels. Covers entire range in only six turns.
9. Simplifies front end design and production.
10. Reduces assembly costs.

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Edited by VIN ZELUFF

Electronic Umpire for Baseball 116
Miniature TV Test Equipment 116
Wide-Range Frequency-Modulated Oscillator 118
Compact Industrial Television System 164
Recording Mass Spectrometer 168
Shop Shortcuts 184

Electronic Umpire (for Baseball)

ANY INVENTIVE electronics or electrical engineer who has ever watched a baseball game has at one time or another considered the possibility of an electronic device capable of determining whether or not a pitched ball crosses home plate within the strike area, which is bounded vertically by the height of the batter's shoulders and knees, and laterally by the extremities of the home plate marker.

As shown in the photograph, the device consists of two main pieces. A ground box, four feet long, 22 inches wide, and 1½ inches deep, is substituted for the conventional home plate. The cabinet, which contains the recording and indicating equipment, is located at some convenient position anywhere up to 25 feet from home plate.

The electronic umpire not only calls the pitched ball a strike or a ball, but it determines the speed of travel as the ball crosses the plate.

In the ground box are lenses and mirrors which enable three phototubes to fence in the strike zone by looking at the sky through three slots in the top of the box, as shown in the drawing. When a ball passes through the strike zone, it casts its shadow on the phototubes in a definite sequence, thereby creating electric impulses which light the strike indicating lamp. An inside or outside ball does not cast its shadow because the phototubes see only the width of the plate. A high or low ball casts its shadow but in an improper sequence. The lamp does not light, indicating a ball was pitched.

The ball must pass through the planes viewed by the phototubes in the proper sequence to be called a strike

The equipment can be adjusted to the height of the player, so that the strike zone outlined will fit any batter, regardless of his height.

The speed of the pitched ball, provided it is a strike, is automatically timed by the device as it passes through the strike zone, giving a reading in feet per second on the recording machine.

The device was developed by General Electric at Electronics Park, Syracuse, N. Y. Their engineers say it will operate even on an overcast day, but not at night. It was developed for training use only and is not intended for use in competition.

Peewee Reese lets a pitched ball go by so it can be judged by the Electronic Umpire

Miniature TV Test Equipment

BY MARVIN KAPLAN

Oak Ridge Products
Chief Engineer
Mfg. Division of Video Television, Inc.
New York, N. Y.

FIELD CHECKS of television receivers are made more convenient by miniature test instruments recently introduced. One of these units is designed to supply signals for video and audio checking of i-f, and high and low bands of a receiver.

All bands are calibrated and tunable on the front panel. A selector switch permits the 6C4 r-f oscillator tube to operate on three bands in a grounded-plate circuit and on a fourth frequency of 4.5 mc as a Hartley oscillator.

The modulator is a 6J6 twin tri-

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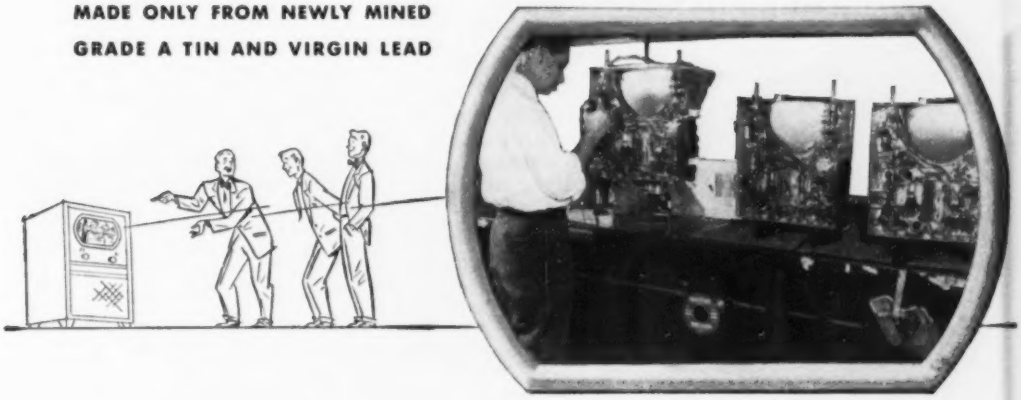

'Resin-Five' Core Solder

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Sweep generator (top) and r-f signal generator are not much larger than a pack of cigarettes

ode used as a multivibrator to produce a 500-cycle pulse to grid-modulate the master oscillator. Output is taken from a coupling loop around the cathode choke in the r-f oscillator circuit. Modulation is removed by shorting one of the multivibrator grids to the ground.

In band A, a tuning range is supplied from 54 to 82 mc (channels 2 to 5), by means of an air-core self-supporting coil tuned by a variable air capacitor.

In band B, the frequency range is 20 to 28 mc which covers the standard video and sound i-f and trap frequencies. The panel, however, is also calibrated with the second harmonic range of 40 to 48 mc for sets employing the new RMA recommended i-f frequencies.

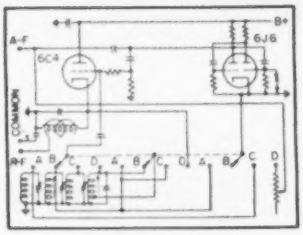
Band C tunes from 85 to 109 mc covering channel 6 and the f-m band. The panel is calibrated also with the second harmonic, 179.75 mc to 215.75 mc for channels 7 to 13. This coil is similar to the one in band A and is tuned in the same fashion.

In the last position of the selector switch two types of signals are supplied simultaneously. The 6J6 multivibrator 500-cycle output is connected with an attenuator control to a jack while the 6C4 oscillator tube is converted to a Hartley oscillator by connecting the cathode of the tube to a tap on a 4.5-mc coil which is pre-tuned at the factory with a fixed capacitor and an iron-core slug. This signal is supplied to another jack by means of the cathode choke coupling loop.

Another instrument in this miniature series is a new type of linearity, sync and sweep tester. Although this unit is called Model 104 Syncro-Sweep generator, it has many other functions. The unit consists of an r-f oscillator section which is calibrated on channel 2 to 5, and a modulator section with a specially designed switching network to provide a variety of frequencies from 400-cycles to about 200 kc. In one position of the selector switch the r-f oscillator is modulated by a variable frequency to provide a series of vertical bars on a television screen to allow a technician to adjust the horizontal linearity of the receiver without a test pattern.

In the second position of the switch, the r-f oscillator is modulated by a variable frequency to provide a series of horizontal bars on the receiver screen which supplies a pattern for adjusting the vertical linearity. In the third position of the switch, a variable frequency modulates the oscillator to provide a transmitted synchronizing signal to check the horizontal sync circuits of a television receiver.

At the same time a saw-tooth



Circuit arrangement of switching functions in the small-size Oak Ridge signal generator

voltage is supplied to an output jack. This signal can be used to generate the horizontal sweep and fly-back voltage in a receiver to help isolate a sweep failure. In the fourth position of the selector switch a variable frequency is supplied to the oscillator to provide a transmitted synchronizing signal to check the vertical sync circuits of a television receiver.

The switch also connects a vertical saw-tooth voltage to an output jack. This signal can be used to generate the vertical sweep in a receiver to help isolate a failure in the sweep circuits.

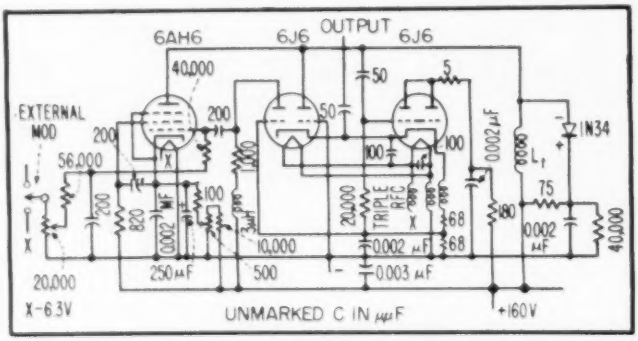
Wide-Range Frequency-Modulated Oscillator

By P. M. Milner
Radiation Laboratory
McGill University
Montreal, Canada

Need arose for a test oscillator with flexible modulation wave form, having a range of 18 to 30 mc for use in the design of control circuits for the McGill synchrocyclotron.

The only previously used circuits of the reactance-tube type known to the author[1] achieve wide deviation by frequency multiplication followed by frequency conversion, resulting in a complicated design

(Continued on p 144)



Final circuit of wide-range f-m oscillator

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THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK

RCA's New Three-Color Picture Tube 120
Ripple Tank for Phase-Front Visualization 120
Rectangular Wave Generator for Biological Studies 122
Microseismic Arclight Timer 190
Magnetic Tape is Memory for Computer 196
Antilogarithm Circuit 200
Measuring pH of Biological Fluids 202
Survey of New Techniques 208

RCA's New Three-Color Picture Tube

SINCE THE RECENT INTRODUCTION of a three-color picture tube, the television industry has become alive with enthusiastic speculation for the immediate future of color television.

The tube, demonstrated in Washington last month by RCA, uses 351,000 color dots, one third of that number being of each of the primary colors, red, blue and green. These color dots are arranged in triangular groups of three dissimilarly colored dots each.

Immediately behind the face of the tube is a metal mash screen containing 117,000 holes. These holes are of approximately the same size as the triangular three-dot groups and are so positioned that they overlap equally the red, green and blue dots of each group.

As the electron beam, or beams, scan the face of the tube, the electrons pass through the holes of the mask. Whether the beam falls on the red, blue or green portion of the individual three-color groups is determined by information contained in the transmitted video signal.

Both single and triple-gun tubes have been produced with the new triangular-dot technique with results that are reported to be exceptionally gratifying.

No information is available as to the relative merits of the single-gun and three-gun versions. The single-gun model requires ten more tubes than a black- and-white receiver, while the three-gun tube necessitates the addition of 19 tubes to a black-and-white circuit.

Receivers

Receivers designed for use with the new tube are completely compatible, since the tube operates on a standard 525-line definition. A television receiver using the new tube will probably cost between 20 and 25 percent more than a black-and-white set, and RCA engineers predict that within a matter of months, color pictures using the tube will be comparable in quality to present-day standards for monochrome pictures.

Because of the fact that all sizes of tubes will have the same number of dots, production techniques are expected to be simpler for larger-sized tubes.

Single-gun three-color picture tube, which is expected to hasten the realization of color television

Ripple Tank for Phase-Front Visualization

CALCULATION or experimental determination of the effects of antenna systems alterations on phase-front configurations are usually very tedious. The Naval Research Laboratory has developed a substitute for such computations by extending the ripple-tank technique used previously for the demonstration of certain two-dimensional phenomena of physical optics. A simplified schematic of the system is shown in Fig. 1.

Equipment

An audio oscillator is the heart of the instrument. Its output is divided between the ripple-forming transducer and a stroboscopic light chopper wheel in such a way that the waves on the surface of a thin film of water appear to be motionless.

The image of the waves is cast upon a ground-glass screen by shining the synchronously chopped light through the waves which act like cylindrical lenses casting stationary light and shadow patterns in accordance with the phase-front pattern set up in the ripple-tank.

The Navy's version is mounted in a six-foot high rack with the ground glass screen at eye level for easy observation. The ripple tank is eleven inches square, and the water film used is approximately a quarter-inch thick. The number of holes in the chopper wheel depends on the problem, since it is sometimes desirable to light every other phase front and sometimes there is cause to light each phase front

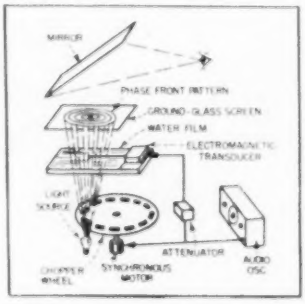

FIG. 1—Basic components of the NRL ripple tank for visual study of phase fronts

Laboratory Instruments for TELEVISION

Type 202-B
FM SIGNAL GENERATOR

Frequency Range
54-216 mc.

Additional coverage from 0.4 to 25 mc. with accessory UNIVERTER Type 203-B

FM SIGNAL GENERATOR
Type 202-B

The Type 202-B FM Signal Generator is specifically designed to meet the exacting requirements of television and FM engineers working in the frequency range of 54 megacycles to 216 megacycles. Following are some of the outstanding features of this versatile instrument:

- **RF RANGES: 54-108, 108-216 mc. ± 0.5% accuracy. Also covers 0.4 mc. to 25 mc. with accessory 203-B Univerter.**
- **VERNIER DIAL: 24:1 gear ratio with main frequency dial.**
- **FREQUENCY DEVIATION RANGES: 0-24 kc., 0-80 kc., 0-240 kc.**
- **AMPLITUDE MODULATION: Continuously variable 0-50%, calibrated at 30% and 50% points.**
- **MODULATING OSCILLATOR: Eight internal modulating frequencies from 50 cycles to 15 kc. available for FM, AM.**
- **RF OUTPUT VOLTAGE: 0.2 volt to 0.1 microvolt. Output impedance 26.5 ohms.**
- **FM DISTORTION: Less than 2% at 75 kc. deviation.**
- **SPURIOUS RF OUTPUT: All spurious RF voltages 30 db or more below fundamental.**

If you have an FM or television instrument requirement, let us acquaint you with full particulars and technical data concerning the Type 202-B FM Signal Generator and Type 203-B Univerter.

UNIVERTER
Type 203-B

AVAILABLE AS AN ACCESSORY is the 203-B Univerter, a unity gain frequency converter which, in combination with the 202-B instrument, provides the additional coverage of commonly used intermediate and radio frequencies.

- **R. F. RANGE: 0.4 mc. to 25 mc. (0.1 mc. to 25 mc. with no carrier deviation).**
- **R. F. INCREMENT DIAL: ± 250 kc. in 10 kc. increments.**
- **R. F. OUTPUT: 0.1 microvolt to 0.1 volt, ± 1 db. Also approximately 2 volts maximum (uncalibrated).**
- **OUTPUT IMPEDANCE: Approximately 60 ohms at 0.1 volt jack, 470 ohms at 2 volt pin jack.**

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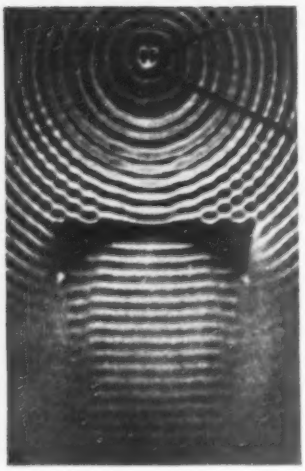


FIG. 2—Typical problems suitable for ripple-tank study include the effects of waveguide lenses on phase fronts

twice, thereby giving the effect of doubling the number of phase fronts.

A photograph of a typical study is shown in Fig. 2. It demonstrates two interesting phenomena. In the first place, two transducers are being used in close proximity to one another. This illustrates the characteristics of multielement antenna structures. This study also stimulates some aspects of W. E. Kock's metal-lens antenna. The lens shown in the photograph was designed for an index of refraction of about 0.55, and was made of ¼-inch thick brass, milled with 32 slots spaced ⅜-inch on centers. The slots were 0.040-inch wide and 3/32-inch deep, and the concave side has a radius of 1¼ inches. Since there is no possibility of interference between the back radiation of the primary pattern and the secondary pattern in the case of the waveguide lens, the side lobe structure due to this cause is absent. Appreciable reflection from the first surface is evident.

The transducer is actually a magnetically driven pin point which is brought into physical contact with the surface of the water. The crest-to-trough amplitude of the waves decreases linearly as the distance from the transducer, as might be expected, for a single isotropic exciter radiating in two dimensions.

The instrument is also usable for single-pulse studies, and when used with models, the reflection of radar-type waves from the surfaces of certain objects can also be studied visually. The ripple tank was shown at the Navy exhibit at the recent IRE Engineering Show in New York, and a description of an earlier experimental model is presented in NRL Report 3559.

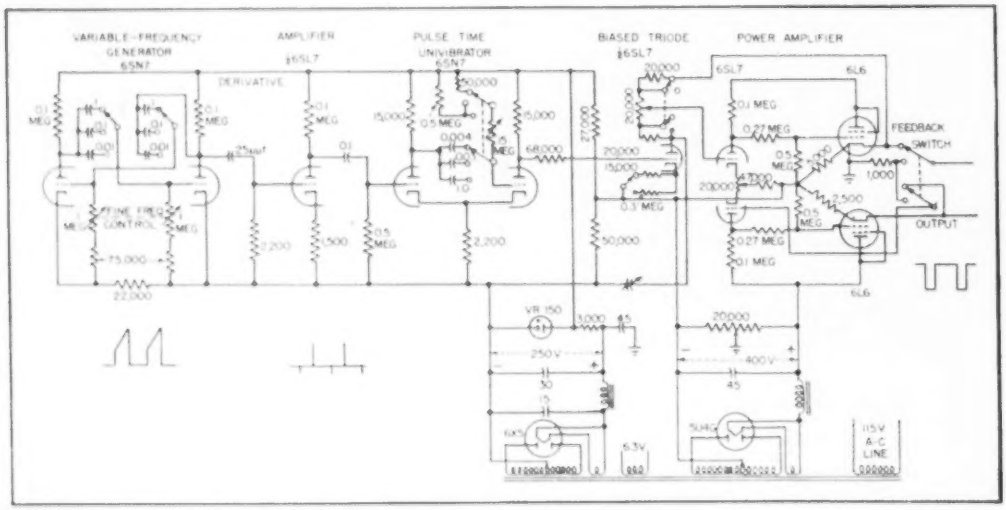
Rectangular Wave Generator for Biological Studies

By JOHN W. MOORE

Physics Department
Medical College of Virginia
Richmond, Virginia

FOR NERVE and muscle stimulation, one method frequently used is the application of a negative rectangular pulse to a small search electrode with respect to a large indifferent electrode (usually at ground potential). The instrument described is ideally suited for this sort of work and has been extensively used in current and voltage transient studies. It has been giving trouble-free service for over two years, producing pulses at continuously variable repetition rates of ½ to 400 cps and continuously

(Continued on p 188)



Rectangular wave generator. Feedback loops give choice of current or voltage output, with pulses continuously variable over wide range of frequency and duration for maximum flexibility in excitation of nerves and muscles as well as for observation of electrical transients through biological systems

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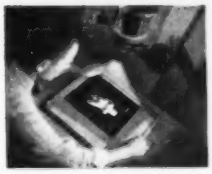
To view your microfilm records in the office . . . the Kodagraph Film Reader. Each image is enlarged sharp and clear . . . easy to read and check . . . on a special green-tinted viewing screen. You can speed the film from image to image . . . get all the information you need—quickly.

To view your microfilm records in the field . . . the Kodagraph Portable Projector. You can flash your records on any screen or light colored wall . . . magnified at dimensions up to several times larger than the original, if necessary. It is convenient to carry—weighs only twelve pounds.



To make enlargement prints from your microfilm records . . . the Kodagraph Micro-File Enlarger. It produces prints of maximum legibility . . . so sharp that they can be used as intermediates in direct process or blueprint machines.

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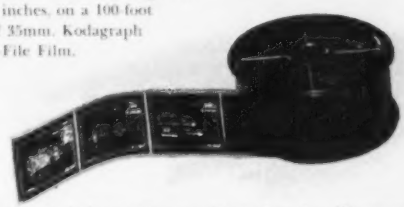

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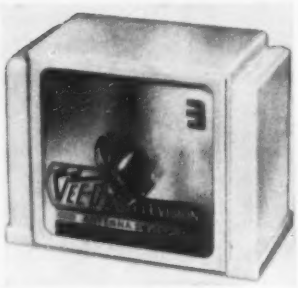
NEW PRODUCTS

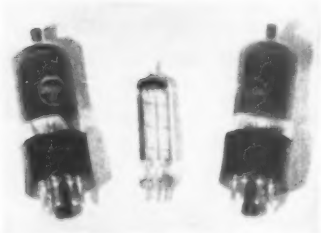
EDITED by WILLIAM P. O'BRIEN

Television's Rapid Stride Forward Lends Impetus to Receiver Tubes and Parts Production . . . Temperature and Shock Protection Loom as Vital Factors in Equipment Design . . . Drift is Toward Wider Frequency Ranges for Test Apparatus



Tele Antenna Switch

THE LAPOINTE PLASCOMOLD CORP., Unionville, Conn. With the Vee-D-X antenna switch it is not necessary to attach a separate transmission line every time a different antenna is to be used. By turning the knob the viewer can change over from one antenna to another. The unit is also useful for tv dealers when demonstrating more than one receiver from a single antenna. It features a low-loss switch that prevents leakage, and a terminal strip at the rear which will accommodate three separate leadins as well as the output line to the receiver.



Tele Receiving Tubes

GENERAL ELECTRIC CO., Schenectady, N. Y., has announced three new tubes designed mainly for television receivers. The 6AS5 is a miniature beam-power amplifier intended for use as the audio power-output tube in television and small radio receivers. When operating with a plate voltage of 150 v and an input signal of 8.5 v peak, 2.2 watts of output power can be realized with 10-percent distortion. The 6BQ6-GT and 25BQ6-GT beam-power amplifier tubes are intended for use as horizontal-deflection amplifiers in television receivers. Maximum ratings of the tubes include a plate dissipation of 10.9 w, a plate current of 100 ma and a peak positive surge plate voltage of 5,000 v.

Precision Potentiometer

SOUTHWESTERN INDUSTRIAL ELECTRONIC CO., 2831 South Oak Road, Houston 19, Texas. The new model P-2 precision electronic potentiometer makes potential measurements on high-impedance electrochemical cells or electronic tubes and circuits. It is suitable for measuring potentials from 0 to 3 volts in three ranges. Current flow in the measured circuit is less than 10^{-11} amperes, making it suitable for use with glass electrodes. A built-in standard cell, combined with a 0.1-percent potentiometer and dual-range dial provides an accuracy of ± 1.0 mv plus 0.1 percent.

VTVM

THE HEATH CO., Benton Harbor, Mich., is introducing a new vacuum-tube voltmeter kit. Positive automatic meter protection on all functions is given by the electronic a-c voltmeter and push-pull d-c voltmeter circuit. The 200-μa unit uses Alnico V magnet for fast, accurate readings and one-percent precision ceramic divider resistors. It includes 24 complete ranges, and the meter pointer can be offset from zero for f-m and tv alignment.

Miniature Rectifier Tube

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Avenue, New York 18, N. Y. Type 1V2 miniature high-voltage half-wave rectifier is designed for television receiver pulse rectifying systems and voltage-doubler circuits for magnetically deflected 10 and 12-inch viewing

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COMMERCIAL MICROWAVE POWER

QK-217

- ★ 1500 watts continuous power at 2450 megacycles.
- ★ Efficiency 50%.
- ★ Unipotential indirectly heated cathode.
- ★ Integral magnet construction.
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QK-174A

F-M communications magnetron

- ★ Tunable 1990-2110 megacycles.
- ★ Frequency modulation 15 megacycles.
- ★ Power 100 watts.
- ★ Efficiency 35%.

Also a complete line of low power klystrons from 6 millimeters to 30 centimeters and pulse magnetrons both high and low power.

Data available on request

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Excellence in Electronics

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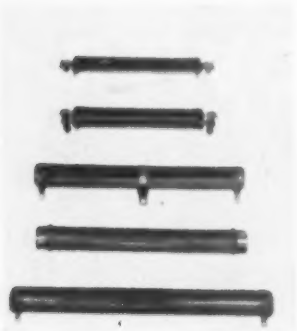
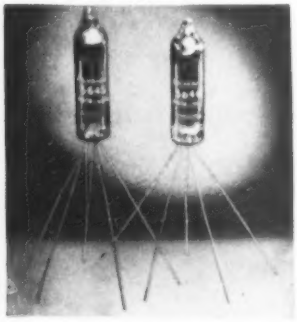
tubes. It has a peak inverse plate voltage of 7,500, a peak plate current of 10 ma and an average plate current of 0.5 ma.



Enamel-Coated Resistors

HARDWICK, HINDLE, INC., 40 Hermon St., Newark 5, N. J. The new blue-gray enamel coating on the resistors illustrated gives greater protection throughout the most rugged service. Fixed, ferrule and flat-type resistors are especially designed and manufactured in accordance with JAN-R-26A specifications. Write for the recently published resistor bulletin.

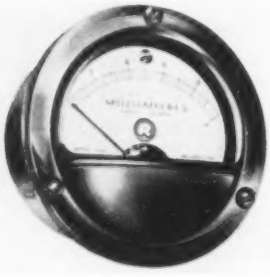


Subminiature Triodes

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York 18, N. Y. Type 5645 medium-mu triode, suitable for Class A-amplifier applications, is 1.3 in. long and 0.31 in. in diameter. Under typical operating conditions the tube will have a transconductance of 2,700 μmhos and an amplification factor of 20. Maximum rated plate dissipation is 1 watt and plate resistance, 7,400 ohms. Type 5645, a high-mu triode, under typical operating conditions, has a transconductance of 2,400 μmhos, an amplification factor of 70 and a plate resistance of 29,000 ohms. Maximum rated plate dissipation is 0.3 watt. Both types have 6.3-volt, 150-ma heaters and flexible leads.

Marker Generator

APPROVED ELECTRONIC INSTRUMENT CORP., 142 Liberty St., New York, N. Y. Model A-450 marker generator is a precision-built tunable oscillator providing a marker, modulated or unmodulated, for indicating frequencies on a displayed frequency response of a television or any wide-band i-f amplifier when used with a sweep generator and an oscilloscope. Frequency range is 19.5 to 40 mc, accurate to 0.5 percent or better. The unit operates on 115 volts, 60 cycles.



Panel Instruments

MARION ELECTRICAL INSTRUMENT CO., Manchester, N. H. The ruggedized panel instruments illustrated feature high shock testing when subjected to 2,000 foot-pound blows in each of three orientations with respect to direction of applied blow. New hair springs reduce zero shift, raise fatigue point and eliminate deformation under shock. Hermetic sealing of the reduced-weight unit gives complete weather protection in any climate.

Plate Circuit Relays

POTTER & BRUMFIELD MFG. CO., INC., Princeton, Ind. The new design of the series LC plate circuit relays includes molded bakelite coil bobbins with solder terminals on the coil periphery. This provides breakdown insulation up to 2,500 volts rms, and the added space in the bobbin allows windings up to 40,000 ohms. The series requires only 90 milliwatts for reliable operation and the ¼ silver contacts are rated at 5 amperes.

Tiny TV Receiver Rectifier

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York 18, N. Y. Type 1X2 is a double-ended miniature high-voltage rectifier tube designed for use with r-f flyback, and 60-cycle types of power supply for television picture tube anodes. Ratings are as follows: filament voltage, 1.25; current, 200 ma; maximum peak inverse plate volts, 15,000; maximum peak plate cur-

(Continued on page 210)

HERE'S WHAT THEY SAY ABOUT audiotape

From all parts of the country—from users in every branch of the recording art—hundreds of reports have come in, commenting on the performance of Audiotape. The typical comments quoted below speak for themselves.

If you haven't tried Audiotape yet, why not see for yourself just what it can do to improve the quality of your tape recordings? Your local Audiotape and Audiodisc dealer will be glad to fill your requirements. Or, write to Audio Devices for a free 200-foot sample reel of either paper or plastic base Audiotape. It will speak for itself.

A Recording Service

"We find that your plastic Audiotape meets our requirements far better than the others we were using. We were bothered with flutter before, but now it seems that our discs we duplicate from tape are of much better tonal quality."

A Sound Consultant

"I have tested the samples on several recorders under various conditions. Both paper and plastic base proved to be as fine as any I have yet used--good frequency range and especially low noise level (inherent)."

A Radio Station

"We find Audiotape to be the best so far obtainable. There is less dust, dirt, and grit accumulation from this tape compared to others--as a result our machine runs at more constant speed."

A University

"We are using No. 1251 to record sound tracks for our educational films. We find the product very satisfactory and particularly appreciate the flat tape that does not hump away from the head in the middle."

A Research Laboratory

"Have found your tape the best for my recorder. Very low noise level and very uniform characteristics are its outstanding qualities. Price is also attractive."

A Home Recordist

"We've compared Audiotape with the tape we've been using and were impressed with the fidelity and low noise level. The output for a constant level 1000 cycle input is remarkably good, showing uniform coating."

A Broadcasting School

"I am happy to report that of several brands of tape tried, Audiotape has the lowest consistent noise level. Over-all response is remarkably consistent for all parts of each reel."

An Industrial Firm

"I find that this tape excels all other makes now on the market in quietness, range, and ease of handling. On the strength of the test sample, have disposed of all other makes and am now using only Audiotape."

A Grammar School

"We have used various tapes in our school work here and really know that yours is second to none. You can expect an order from us shortly."

A Radio Station

"We are very pleased with your Audiotape samples. Noise level very low and quality excellent. We use it whenever a good reproduction is desired. We find your tape and your discs best in the field."

A University

"We are delighted with the plastic base sample and in the future plan to order it exclusively. In speech work fidelity is very important, and we feel that the plastic Audiotape is the best we have tried."

A Radio Station

"Results from tapes tested--excellent. Low noise levels --low distortion. Seems to be less capstan slippage than other tapes. Attractive prices. All future purchases by us will include Audiotape."

A College

"Thanks for the Audiotape samples. We are using your plastic base tape exclusively for the original recording of our radio programs. We find that there is practically no loss dubbing from tape to discs."

A Radio Station

"Excellent tape--much less flutter due to its ability to fit head contours better. All of our new tapes will be Audiotapes."

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NEWS OF THE INDUSTRY

EDITED by WILLIAM P. O'BRIEN

New Microwave Installation

ONE of the largest microwave installations in the country will provide modern protective and operating devices for network transmission facilities over the Bonneville power system in the Pacific Northwest. A contract for the system equipment has been awarded by the Bonneville Power Administration to the Philco Corp. of Philadelphia on a bid of $633,492.

The system will link all major dispatching centers, substations and federal power plants in the Pacific Northwest with voice communication, relaying, telemetering and fault-location channels. Construction of six microwave towers and substations for initial installation of equipment between Portland, Vancouver, Wash., and Seattle load and dispatching centers is nearing completion.

Microwave terminal and way stations will be located at Bonneville substations and dispatching centers near Vancouver, North Bonneville, Trinidad, Snohomish, Coulee City, Spokane and Vernita, Wash., and Portland and Troutdale, Ore.

Major power grids to be provided with microwave facilities include high-voltage facilities from Portland-Vancouver to Seattle, with loops to Chief Joseph and Grand Coulee dams and Spokane, and east from Portland to McNary Dam and eventually from Spokane to Hungry Horse Dam and from Portland to Eugene, Ore.

Microwave radio is expected to to effect substantial savings in maintenance and operating costs through instant detection of transmission faults before extensive damage results, and greatly curtail serious system outages through detection and operating facilities.

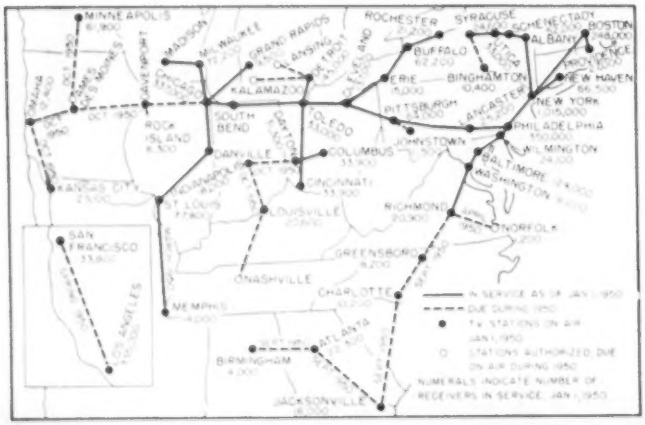
NAB Recording and Reproducing Standards

LEADING recording engineers of the nation met with the full National Association of Broadcasters' recording and reproducing standards committee in Chicago on April 15, at the close of the Engineering Conference portion of the 28th Annual NAB Convention.

The meeting was held to consider adoption of additional recording and reproducing standards, mainly devoted to magnetic tape recording. Most recent NAB recording and reproducing standards prior to this were adopted at the 1949 NAB convention. The standards apply to all types of recording and reproducing, and serve as engineering guides to manufacturers as well as recording engineers and audio specialists.

New standards proposed are designed to standardize magnetic tape reels, hubs and flanges, so that tape may be played more satisfactorily on all makes of equipment. After approval by the NAB board of directors the new sections will be incorporated in the printed Standards.

1950 TELEVISION NETWORK ROUTES



Permission to reproduce the above map was given by *Television Digest with AM FM Reports*

Electronic Components Conference

A THREE-DAY conference sponsored by the AIEE, IRE and RMA, with the cooperation of the military services, the Research and Development Board of the Department of Defense, and the National Bureau of Standards will be held May 9 to 11, at Washington, D.C.

Purpose of the conference is to discuss improved quality components for greater dependability of radio-electronic equipments, unitized packaging as a means of simplified maintenance, miniaturization, and circuit elements suitable for unit package design. Discussion will be from the viewpoint of military equipments, commercial aviation, industrial instrument and control, commercial radio and television, and mobile communications equipments.

Advance registration for the conference may be obtained by sending $2 to A. E. Zdobysz, Bureau of Aeronautics, Building W, Room 1W91, Navy Department, Washington 25, D. C. Reservations for copies of the conference report may be made before May 9 through A. E. Zdobysz, conference treasurer, or through R. S. Gardner, AIEE headquarters, 33 W. 39th St., New York 18, N. Y., either before or after the conference.

Industrial Fellowships in Electronics

A NUMBER of graduate and advanced research fellowships are offered by MIT for study and re-

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search in the field of electronics. They are known as Industrial Fellowships in Electronics and are sponsored jointly by a group of industrial organizations concerned with the advancement of electronics and its applications.

Applicants must satisfy the requirements for admission to the graduate school on recommendation of the Department of Physics or the Department of Electrical Engineering. Recipients of such fellowships will pursue programs of study and research leading toward advanced academic degrees in physics or electrical engineering. It is expected that the area of specialization of a Fellow will fall within the field of electronics.

There will be awarded a few Advanced Research Fellowships to candidates possessing the Ph.D. degree or its equivalent who, without enrolling as graduate students, wish to pursue advanced studies and research in electronics at MIT.

Recipients of a graduate student fellowship will be awarded a stipend varying between $1,200 and $1,800 according to their experience and qualifications, and in addition will be granted a credit to meet the tuition fee. Advanced research fellowships will range from $2,400 to $3,600 according to the qualifications of the recipient.

Applicants for an industrial fellowship in electronics should communicate with the Director, Research Laboratory of Electronics. Application should be made at least four months prior to the intended date of entrance.

MEETINGS

MAY 3-5: 1950 Dayton IRE Technical Conference, Dayton Biltmore Hotel, Dayton, Ohio.

MAY 9-11: Conference on Improved Quality Electronic Components, 1317 F Street N W, Washington, D. C.

MAY 12-13: Fourth annual meeting of the Armed Forces Communications Association, Hotel Commodore, N. Y., and Fort Monmouth, N. J.

MAY 22-25: Parts Distributors Show, Hotel Stevens, Chicago.

JUNE 1-2: Fourth National Convention and Fifth Midwest Conference of the American Society for Quality Control, Milwaukee Auditorium, Milwaukee, Wisc.

JUNE 12-16: AIEE Summer and Pacific General Meeting, Huntington Hotel, Pasadena, Calif.

JUNE 26-30: Annual Meeting and 9th Exhibit of Testing Apparatus and Related Equipment, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

AUG. 23-26: AIEE Pacific General Meeting, Fairmont Hotel, San Francisco, Calif.

AUG. 27-31: NEDA National Convention and Exhibition, Cleveland Public Auditorium, Cleveland, Ohio.

AUG. 28-31: APCO National Conference, Hotel Hollenden, Cleveland, Ohio.

SEPT. 11-23: URSI Ninth General Assembly, Zurich, Swjtzerland.

SEPT. 13-15: Sixth Annual Pacific Electronic Exhibit, Municipal Auditorium, Long Beach, Calif.

SEPT. 18-22: Fifth National Instrument Conference and Exhibit, Memorial Auditorium, Buffalo, N. Y.

SEPT. 25-27: National Electronics Conference, Edgewater Beach Hotel, Chicago, Ill.

OCT. 17-21: AIEE Midwest General Meeting, Netherland Plaza Hotel, Cincinnati, Ohio.

New Memory Tube

DEVELOPMENT of a radio tube that can remember what it is told and reproduce its information on request was recently announced at the IRE Convention and Radio Engineering Show in New York City, by engineers from MIT.

The new tube, which looks like a glass automobile muffler with an extra pipe coming out of one end, has been developed for use in a high-speed computing machine now under construction at MIT under the auspices of the Office of Naval Research.

Its 400-digit memory should make the tube useful in any computer, communication and information-handling systems using coded data at high speeds. The new memory tube will hold its information indefinitely, as long as power is supplied. It can receive a number to be remembered in twenty-millionths of a second and give one out, when needed, just as fast. When it puts a number into storage, the tube sends back a check signal which verifies that the correct number has been memorized. The tube can also report on stored information without erasing it and old signals can be cleared by putting new ones on top of them.

Storage tubes of the type described are important in computing machines because they can be used as notebooks in which the machine keeps track of problems, instructions, and partial answers in the course of a computation.

The new tubes operate by storing dots of electric energy on a round storage surface. Each tube will record a choice of only two digits—either zero or one, yes or no—in any of 400 different positions. The development is thus especially tailored to the needs of that type of computing machine which solves all its problems in terms of so-called binary digits. In such machines a numerical system involving only two digits is substituted for the familiar ten-digit system. Conventional numbers higher than 0 and 1 are represented by combinations of those two. The electrostatic storage tube might treat the number 2 by remembering an 0 in one location and a 1 in a different location.

The storage tube is built somewhat like a television tube. A fast, high-voltage electron beam is used as the writing beam to apply yes or no voltages to a storage surface. A smaller stream of low-speed electrons continuously sprays this same target surface to hold the information from leaking off.

The storage tube's memory takes place on electrical islands made by beryllium metal deposited on a sheet of insulation in a minute checkerboard pattern. The writing beam of the tube can select a small area of this storage surface consisting of 10 to 20 adjacent beryllium islands, and apply either of two voltages, one meaning yes and one

(Continued on page 248)

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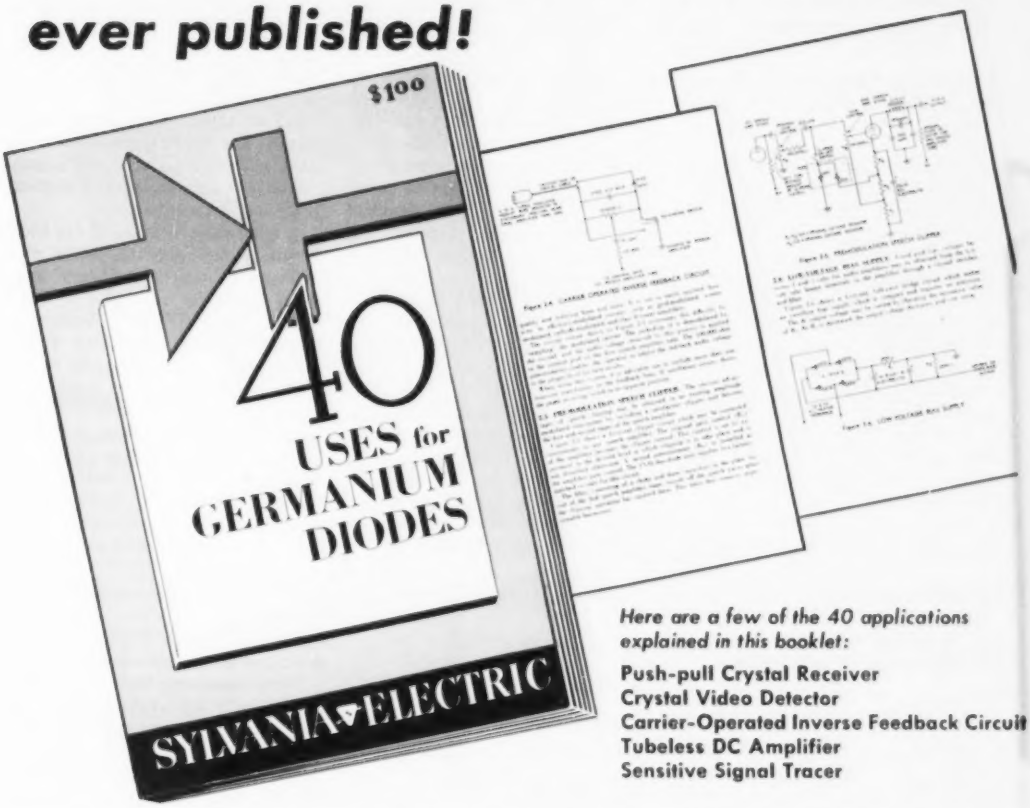

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NEW BOOKS

Frequency Modulated Radar 132
Advances in Electronics, Volume II 134
Terrestrial Radio Waves 135
Electronics: Experimental Techniques 136
Elementary Pile Theory 142
Books Received for Review 142

Frequency Modulated Radar

BY DAVID G. C. LUCK. *McGraw-Hill Book Co., New York*, 1949, 466 *pages*, $4.00.

AT THE CONCLUSION of World War II, little time was lost in publishing in great detail virtually all phases of the theory and techniques associated with pulse radar. The MIT Radiation Laboratory Series is perhaps the most notable example, but several other books, plus a great number of articles in the periodical literature, have served to give pulse radar extended coverage and discussion. It is, therefore, surprising to note that even at this late date, little reference is available on the subject of f-m radar. Despite the fact that f-m altimeters were used by all principal contestants in the last war, no substantial information has been provided except in classified reports.

This book is aimed at and succeeds well in correcting this oversight. Written originally as a final Navy report on an extensive development and production contract undertaken by RCA, it deals with basic theory, applications and systems design.

Theory is presented in simplest possible form. To insure this, the author confines his analysis to the case of symmetrical sawtooth modulation, so that the upsweep beat note and downsweep beat note have constant values except near turnover points. In this way a clear physical picture is presented, as well as the basic factors which establish ultimate performance. This accomplished, other types of modulation and their particular advantages are briefly discussed, exclusive of mathematical detail.

The basic elements of the system as used in practice are described, such as antenna, oscillator, amplifier, limiter and counter. In this connection a very clear, if somewhat limited, account is given of beat-frequency waveform, its treatment by circuits of different characteristics, and its ultimate effect in producing fixed errors. In a section on simple fire-control kinematics, the directness and economy with which f-m radar can supply the needed data for certain tactical problems is described.

A substantial portion of the book discusses the characteristics and makeup of several military systems, such as AN/APN-1 Altimeter, AN/APG-4 Automatic Bombing, and several others. These descriptions are necessarily brief, but in general include block diagram, simplified schematic, and a discussion of significant features, such as primary function, indicator display, and controls provided. In addition, several equipments are discussed whose developments were

(continued on page 134)

BACKTALK

This Department is Operated as an Open Forum Where Readers May Discuss Problems of the Electronics Industry or Comment Upon Articles Which ELECTRONICS Has Published

Electrons to the Rescue

DEAR SIRS:

WILL YOU ADD THIS LETTER to the museum you will have when your 30,000 readers send in their solutions to Prof. Schumann's dilemma?

The professor complains of mice. Your *New Products* department lists, in the March, 1950, issue, page 214, what is the good gentleman's *best* solution.

Would you be willing to contribute your most dog-eared copy of ELECTRONICS for bait?

As a subsidiary topic, may the coined word CAAT be considered along with Mr. Wouk's COVAT? (*Backtalk*, March 1950) The COntinuously - Adjustable-Auto-Transformer which he first mentions is just as amenable to alphabetizing and with as good or better results.

HAROLD S. HANSON
New York, N. Y.

Gain of Helical Arrays

DEAR SIRS:

E. DILLON SMITH'S article in the February issue of ELECTRONICS, "Constructing Helical Antennas", deserves commendation for presenting in practical form a new technique of the antenna field.

I was impressed, however, by the exceptionally high values (listed in Table III) of power gain claimed for antenna systems composed of helical arrays as compared to the dipole system. Upon investigation it appears that Mr. Smith obtains these values theoretically by multiplying the measured gain in decibels of an individual helix by the number of elements in the array. This procedure leads to erroneous results.

The gain of an antenna depends only upon its radiation pattern which, in turn, is a function of the spacing and the radiation pattern of the individual array elements. An exact determination of power gain requires an integration process on the radiation patterns; this cannot be done here since Mr. Smith supplies no data on his spacings. An approximate method, de-

(continued on page 258)

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This book is a most complete and comprehensive treatment of the subject and should prove especially valuable as a quick review of essential theory, as well as a refresher for advancement in the field. It lists all the QUESTIONS and ANSWERS for the FCC examinations. However, the outstanding feature of this volume is its thorough, FOLLOW-THROUGH . . . a carefully simplified discussion of the answer to the technical questions so necessary for a complete and absolute understanding of the answer. Useful appendices which include Small Vessel Direction Finders and Automatic Alarm, not ordinarily available in a book of this type, provided a valuable "extra."

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TELEVISION INSTALLATION TECHNIQUES

by Samuel L. Marshall

This book, written by Mr. Marshall, television instructor at the George Westinghouse Vocational High School, is a practical, easy-to-understand treatment of information pertaining to the antenna, transmission lines, receiver adjustments, and above all, the mechanical requirements, whether they be for a short mast for short distance reception or for the installation of a tower. Including foundation. Both theoretical and practical aspects of every phase of this activity. From the topmost element of the antenna to the ground connection on the receiver terminal board, are fully discussed.

VACUUM-TUBE VOLTMETERS

by John F. Rider

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480 Canal St., New York 13, N. Y.

not complete until after the war.

There is no doubt that in certain single-target problems requiring rapid measurement of speed and range, f-m radar has decisive advantages over pulse radar. In a final section of the book the author compares them for multiple-target problems. Here pulse radar stands in the stronger position, the chief reason perhaps being the simplicity of data display. However, several calculations and arguments are presented (admittedly not yet confirmed by experiment) to show that for systems of equal average power, antenna gain, etc, the two systems are quite equivalent in theoretical data-gathering ability. Economical display and use of this data by f-m systems will, in the author's opinion, emerge when the latter has received a fuller share of development effort.—JOHN F. MCALLISTER, JR., *General Electric Co., Electronics Park, Syracuse, N. Y.*

Advances in Electronics, Volume II

EDITED BY L. MARTON, *National Bureau of Standards, Academic Press Inc., New York*, 1950, 378 *pages*, $7.60.

ENCOURAGED by the reception of Volume I by the scientific community, the editors of that volume have now gathered together eight additional small monographs and have produced a second volume of what promises to be an annual yearbook.

This book deals more with physical electronics than with engineering electronics, the first three of the included papers covering aspects of electron focusing and the fourth, cathodoluminescence. The second half of the book approaches engineering to a slightly greater degree, the subjects treated being breakdown in dielectrics, microwave magnetrons, ferromagnetic phenomena and spectroscopy.

The authors are five-eighths international, as the contents below will indicate. As in Volume I, the approach is thoroughly technical. Each chapter represents a survey of present-day knowledge of the subject. The contents of this volume follow:—

Cathode Ray Tube Progress in the Past Decade with Special Reference to Manufacture and Design, by Hilary Moss, Elec-

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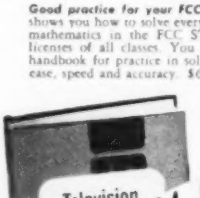

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Ferromagnetic Phemonena at Microwave Frequencies, by George T. Rado, Naval Research Laboratory.

Microwave Spectroscopy, by Donald K. Coles, Westinghouse Research Laboratories.—K. H.

Terrestrial Radio Waves

BY H. BREMMER. *Elsevier Publishing Co., Inc., New York*, 1949, 343 *pages*, $5.50.

DR. BREMMER, whose name has long been associated with the theory of radio-wave propagation, here presents the results of many years of inspired effort. The work is entirely mathematical although one chapter is devoted to a collection of formulas for numerical evaluation of ground-wave intensities, and a number of graphs exhibit the basic phenomena of both ground wave and ionospheric transmission for a number of radio frequencies and varying soil and ionospheric conditions.

The author is to be commended for avoiding the pitfalls associated with discussion of an assumed plane earth and plane ionosphere and for the emphasis he has given to physical interpretation of the necessarily complex mathematical discussion. In general, he uses two methods for treatment of the electromagnetic field, one having the characteristics of diffraction theories and the other leading to geometric-optical interpretation.

After a short introduction the work is divided into two parts; five chapters deal with transmission in a homogeneous atmosphere and five discuss extension of the theory to ionospheric transmission and refraction in the lower atmosphere. The influence of the earth's magnetic field is considered in the final chapter.

It is the reviewer's belief that, in the case of ionospheric transmission, this is the first serious evaluation of what may crudely be called the focusing and defocusing effects of the atmosphere on pencils of rays. It is clearly shown that these

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often have more serious effects upon the field intensity than does absorption. Unfortunately it is apparently beyond the scope of even the complex mathematics of this book to deal with multiple stratification, so that the interesting effects of combined *E* and *F*-layer transmission are not derived.

The order of the mathematical transformations and approximations used will be discouraging to most radio engineers, but the author has usually managed to keep his line of reasoning clear. It is to be regretted that the subject is necessarily so complex, but it is an important one. This work brings much of it within the realm of anylytical discussion. The book is not one to be read lightly, but it will generously reward intensive study.
—J. A. PIERCE, *Cruft Laboratory, Harvard University.*

Electronics: Experimental Techniques

National Nuclear Energy Series, Division V, Volume 1, *edited* BY W. C. ELMORE AND MATTHEW L. SANDS. *McGraw-Hill Book Company, New York,* 1949, 417 *pages,* $3.75.

IN THE EXPERIENCE of this reviewer this is the first book written by physicists for physicists which deals exclusively with electronic techniques. The title is correctly chosen only for physicists. The definition of the content as given in the flyleaf cover represents much more faithfully the intention of the authors. This is not a treatise on experimental electronic techniques; it is a volume describing in detail a series of excellent devices which have been designed, tested and modified until they meet satisfactorily many of the needs of the nuclear physicist. The devices are described for other physicists who will encounter the same or very similar problems. Whether this volume will also be used effectively to constitute the basis for the design of completely new circuits is a debatable question.

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consist of about 60 volumes. Division V of these volumes covers the work done at the Los Alamos Laboratories.

In some cases circuits are described with but few explanations of design criteria. In other cases, exhaustive qualitative and sometimes quantitative discussions are given. It appears strange to a radio engineer, but perhaps not to a physicist, to find in the same volume many pages on circuit components and construction practices which can be found in handier form in most reference books or which are well known to anybody who has done any amount of work in an electronics laboratory, and at the same time to see only a few pages devoted, for instance, to feedback circuits. Descriptions of the Los Alamos equipment which form the bulk of the text are often of the instruction-book type, are very thorough and include mechanical layout information.

In the first chapter electrical components and chassis construction problems are dealt with. In the second chapter, the only one devoted exclusively to basic information, one finds descriptions of the fundamental elements of electronic circuitry from the most elementary to the most advanced type. Short descriptions are given of R-C amplifiers, shunt-peaking coils, delay lines, relaxation oscillators, phase inverters, multivibrators and flip-flop circuits. Particular emphasis is always given to transient response of all the circuit elements. This emphasis makes this chapter very interesting and it is to be regretted that only one chapter has been devoted to this part of the subject matter.

The large mass of material and the little space devoted to it made it impossible for the authors to maintain a balanced presentation. The information presented is often sketchy and incomplete, and reference must often be made to the detailed equipment descriptions in the following chapters to fill some of the gaps.

The third chapter covers voltage amplifiers, particularly pulse amplifiers; pulse shaping and transient response of wideband amplifiers are also thoroughly discussed. It

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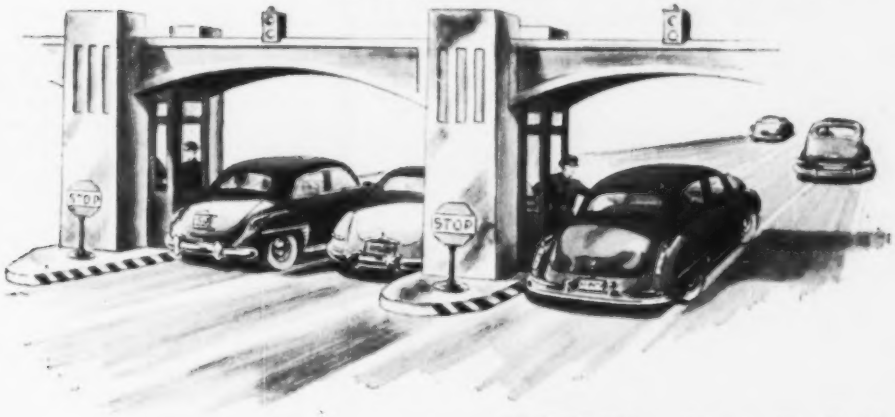

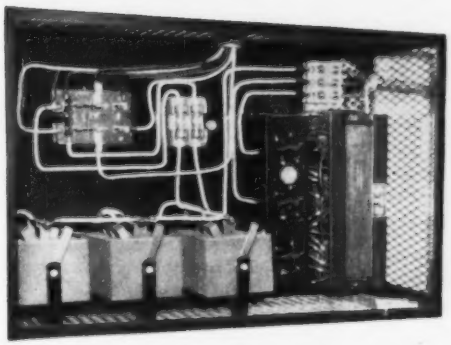

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is regrettable that in a book published in the year 1949 no mention is made of distributed amplifiers and that the concept of noise figure is not even introduced. Pulse amplifiers built by the Los Alamos Laboratory are described in detail together with some d-c amplifiers and some miscellaneous low-frequency, wide-band and pulse-stretching amplifiers.

The fourth chapter covers electronic counters, which are obviously a subject of paramount importance for nuclear physics. From this chapter on, to the end of the book, the reader gets more and more often the impression that the authors are condensing the instruction books prepared by the Los Alamos Laboratory. It must be stated, however, that detailed descriptions are given of the methods employed for the testing and construction of these circuits and some general discussions of the basic problems are added. In the last chapters oscillographs and associated equipment are discussed; test and calibration equipment, power supplies and control circuits conclude the volume.

In conclusion, about two-thirds of the 400 pages of this book are devoted to descriptions of equipment and one-third to information of a general type. The equipment described appears to be of very high quality; with few exceptions, nearly the best available today. There is little doubt, therefore, that this volume will be at least for a few years of the utmost usefulness in all physics laboratories. On the other hand, the average radio engineer will consult this book only if he deals with problems which approximate those encountered by physicists. Since clever circuits and interesting details are hidden in the description of a piece of equipment, the experimenter will not find this book conducive to radical departures from established techniques.

It is clear now why it is difficult to make general statements on the value of this book. The goal of collecting in a single place the information on high-quality equipment built at Los Alamos has been reached very successfully. The usefulness of this book and its perma-

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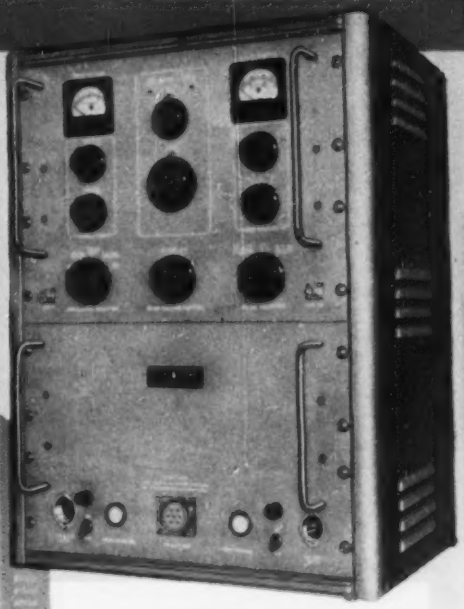

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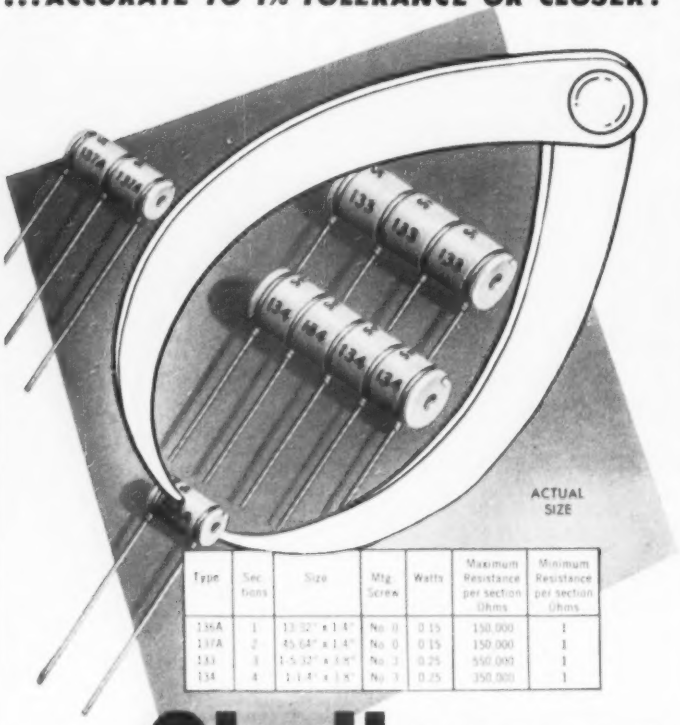

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nent value would have been greatly enchanced if the title of the book had more accurately represented its content and if a more complete treatment has been given of the basic circuit elements, even at the price of less detailed equipment descriptions.—E. G. FUBINI, *Supervising Engineer, Airborne Instruments Laboratory, Mineola, New York.*

Elementary Pile Theory

BY HARRY SOODAK, *Research Associate, Massachusetts Institute of Technology* AND EDWARD C. CAMPBELL, *Senior Physicist, Oak Ridge National Laboratory. John Wiley & Sons, Inc. New York,* 1950, 75 *pages,* $2.50.

IN A CHAIN-REACTING pile, fast neutrons are produced by fission. Some of these neutrons, after being slowed down by a moderator, strike other fissionable nuclei to produce additional neutrons and thus keep the chain reaction going. This volume deals with the processes within such a reactor or pile; as such it is of interest to any engineer or scientist who wishes to have in concise form the basic facts about these nucleonic reactions.

The elementary part of the title means that the elements of the subject are found in the book; the subject itself is not so elementary. In fact, it is no more elementary or simple than the derivation of the three-halves law for electron emission, or of the use of Maxwell's equations to understand what happens in waveguides. If, however, the reader is willing to undergo slight mental effort, he will learn a great deal about this new form of energy with which all engineers must sooner or later deal, each in his own way.—K. H.

• • •

Books Received for Review

TELEVISION TUBE LOCATION GUIDE. Compiled and published by Howard W. Sams & Co., Inc., Indianapolis, Ind., 1950, paper cover, $1.50. Over 200 television receiver chassis layout diagrams with all tubes identified by type and function.

RADIO OPERATING QUESTIONS AND ANSWERS. By J. L. Hornung. McGraw-Hill Book Co., New York, 1950, 10th Edition, 588 pages, $4.50. Answers to FCC examination questions for all seven elements, including a total of 266 questions dealing with special air navigation problems and other topics in the new Element 7.

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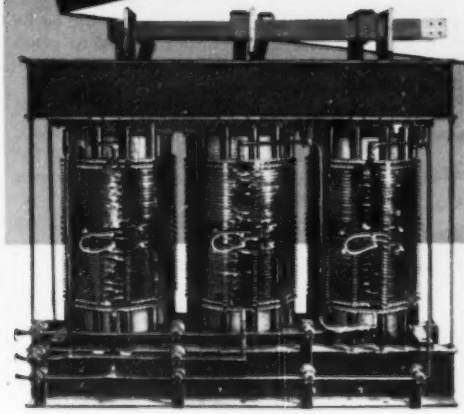

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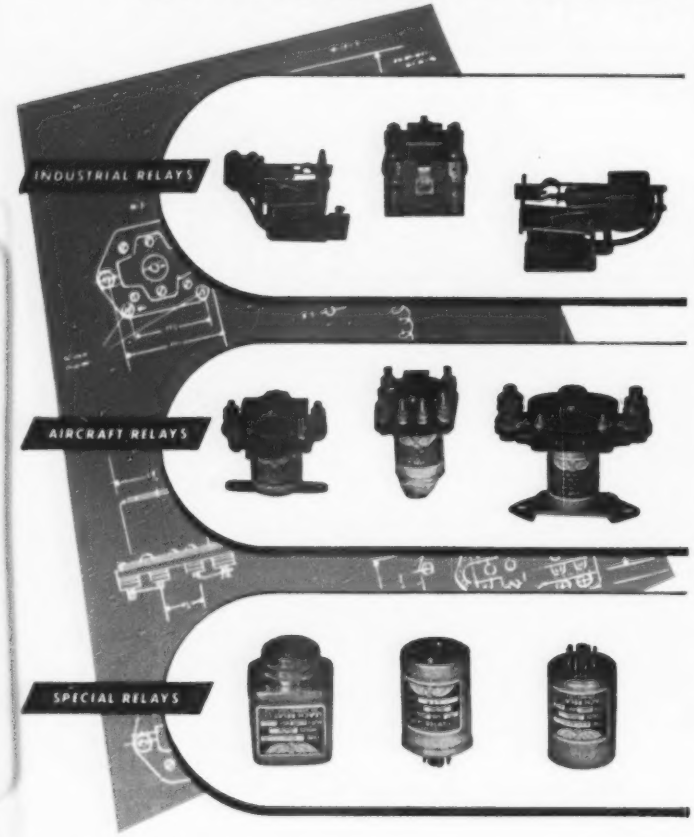

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TUBES AT WORK

(continued from page 118)

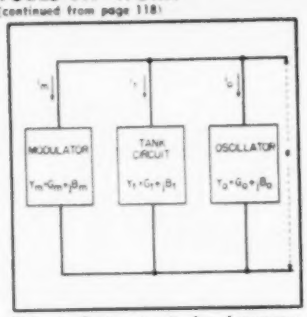

FIG. 1—Basic circuit for frequency-modulated oscillator

and low output. The circuit to be described provides at least as great a deviation with a substantial saving of space and tubes.

The basic circuit has been divided into oscillator tube, tank circuit, and modulator tube (including the phase-shifting network), as shown in Fig. 1.

Let G_o, B_o; G_t, B_t; G_m, B_m; be the conductances and susceptances respectively of the oscillator, tank circuit, and modulator tube. Then the two equations governing the oscillations are:—

$$B_o + B_t + B_m = 0 \qquad (1)$$

$$G_o + G_t + G_m = 0 \qquad (2)$$

It may be shown that the best tank circuit for the present purpose is the usual parallel L-C network.

Results of mathematical analysis are shown in the graph of Fig. 2. Curves of susceptance against frequency are drawn for two parallel L-C circuits, both having the same C, 16 $\mu\mu$f, but for curve A, L is large, 160 μh, and for curve B, L is small, 1.6 μh. Each curve cuts the frequency axis at the value of ω_o for the curve. Values of $\Delta\omega$ for positive values of B_m are shown as a_1 and b_1. Negative values are a_2 and b_2.

For the maximum deviation, a

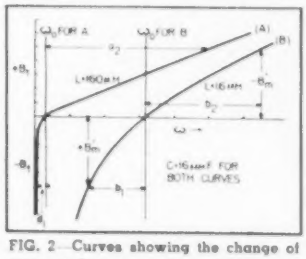

FIG. 2—Curves showing the change of resonant frequency of two L-C circuits when a fixed susceptance is shunted across each circuit

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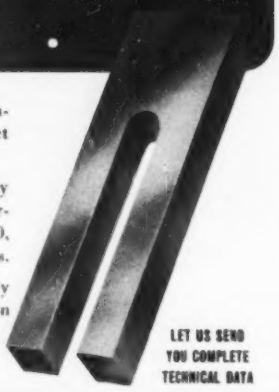

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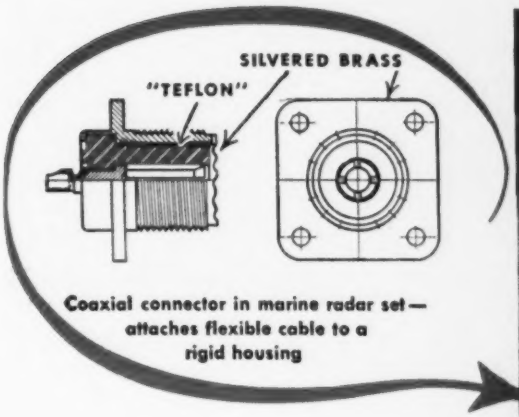

Coaxial connector in marine radar set—attaches flexible cable to a rigid housing

Tough new plastic has low dielectric constant, low loss factor, excellent heat-resistance

Connectors made by Industrial Products Division, Danbury Knudsen, Inc., Danbury, Conn., for Sperry Gyroscope Co., Great Neck, L. I., N. Y.

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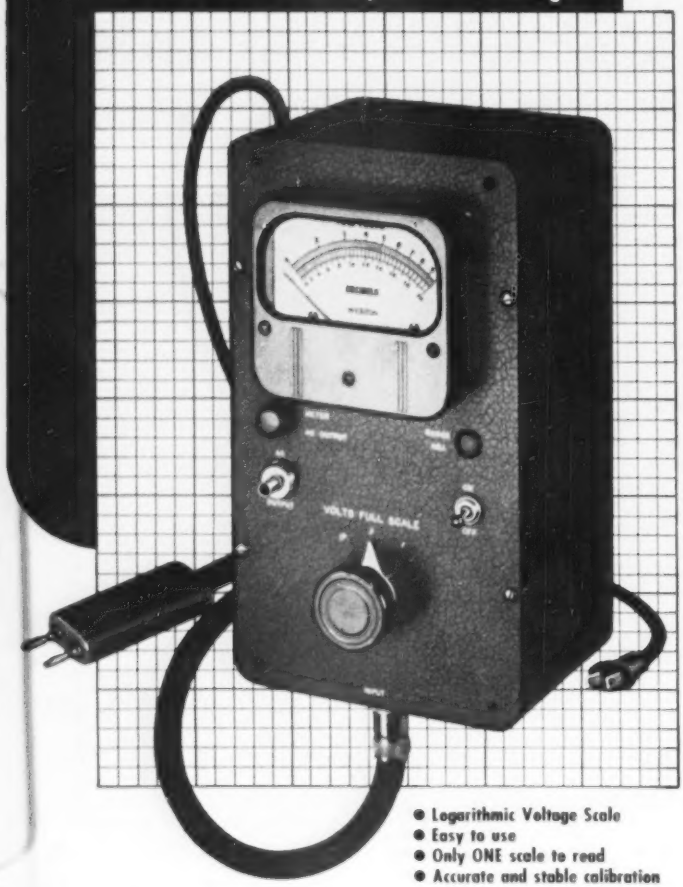

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MODEL 304 R.F. VOLTMETER. This instrument measures AC voltages over a range of 1 millivolt to 100 volts from 30 cycles to 5.5 megacycles. Probe type input connector attached by a flexible cable provides true indication of voltages at point of origin in circuits. Accuracy of voltmeter readings are within 5%. Input impedance is 1 megohm shunted by 9 mmfds. Can be used as wide-band amplifier. Especially useful for reading millivolts in television and FM intermediate frequency amplifier circuits, RF heating apparatus, carrier current systems and in particular for extending useful frequency range of ordinary oscilloscopes to beyond 5 megacycles.

PRICE....$225.00

In addition to the Model 304 R.F. Voltmeter, Ballantine Laboratories also manufacture AC and Battery Operated Audio Frequency Electronic Voltmeters, Peak to Peak Voltmeters, Geiger-Muller Counter Tubes, and the following accessories—Decade Amplifiers, Multipliers, Precision Shunt Resistors, etc.

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BOONTON N. J. · U.S.A.

large tank inductance, a small tank capacitance, and a negative value of B_m are required. The negative value of B_m indicates that the voltage on the grid of the modulator tube is lagging the voltage on the anode.

The minimum value of C_t is the stray capacitance across the tank circuit, the major contributors to which are the oscillator and modulator tube capacitances and the capacitance loading of the phase-shift network. The need for small C_t also limits the maximum useful value of L_t because above a certain size, the advantage to be gained by further increase is lost by the resulting increase in C_t.

Two-Tube Unit

The calculation of the theoretical maximum value of B_m to be obtained with the resistance-capacitance phase-shift network directly shunting the tank (Fig. 3), is long and not very useful, so it will not

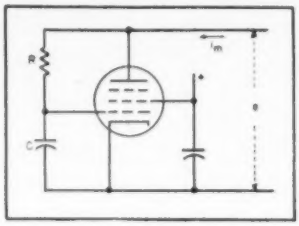

FIG. 3—R-C phase-shift frequency modulator

be described here. However this circuit has the advantage of requiring only two tubes, and will give adequate bandwidth for many purposes.

To make B_m negative, the resistor should be between the anode and the grid of the modulator tube; and to keep the impedance of the phase-shift network high, the input capacitance of the tube should be used for the other element of the network. To prevent shunting of the resistor by the grid-anode capacitance, a pentode must be used as modulator, and a tube having high mutual conductance and low interelectrode capacitance, such as the 6AK5, is necessary. To utilize the maximum mutual conductance, the r-f signal on the grid of the modulator should occupy only a

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VMF-5	5	100	0.1	85
VMF-10	10	100	0.1	135
VMF-20	20	100	0.1	200
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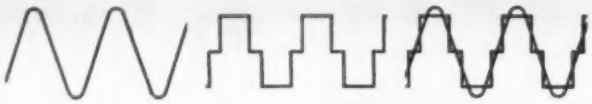

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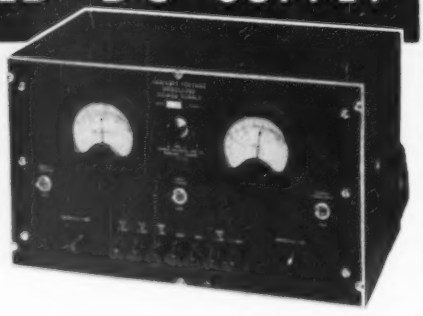

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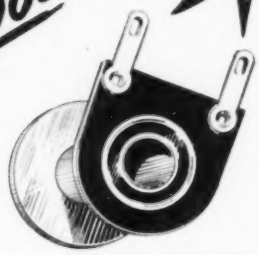

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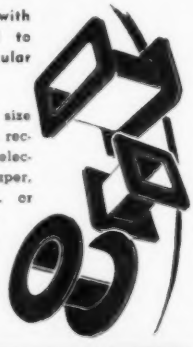

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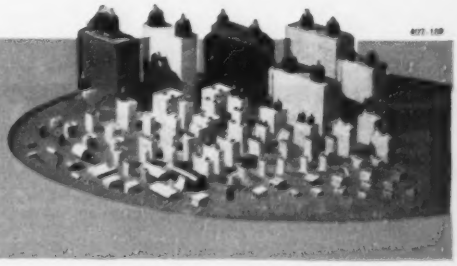

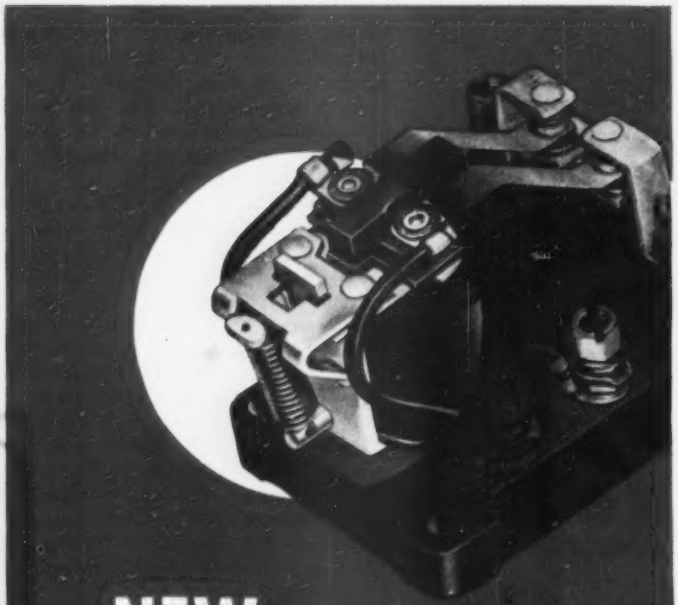

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fraction of the grid base.

Adjustment of the phase-shift network to produce a phase shift of 45 degrees at the highest frequency of the oscillator would give the maximum reactive component of the anode current, but unfortunately it would give an equal resistive component which, in practice, usually makes $G_m > -G_o$, thus violating the condition for oscillation of Eq. (2).

The limitation to the maximum value of B_m appears therefore to lie in the design of the oscillator. In practice with a 6AK5 modulator and 6J6 oscillator, the resistor to be used in conjunction with the input capacitance of the tube must not be less than about 800 ohms. An inductance of 2 to 3 μh in series with the resistor increases the sweep a little and reduces the load imposed by the phase-shift network on the oscillator.

Amplifier Added

A better method of feeding the modulator, Fig. 4, is to use an amplifier which can be adjusted to give a phase shift closely approximating 90 degrees with less attenuation than the R-C network just described, and with much less loading of the oscillator.

To avoid positive feedback between the modulator and the amplifier, the amplification is achieved without phase reversal by a grounded-grid triode, cathode fed by a cathode follower.[3]

Most conventional oscillators depend on a transformer action of the tank coil to provide positive feedback, and it is to be expected that if the greater part of the oscillatory current is shunted through the modulator tube, this will interfere with the operation of the oscillator. To relieve the tank coil of this

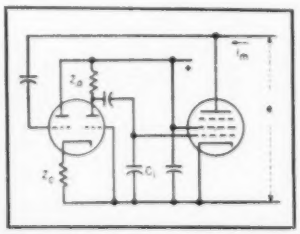
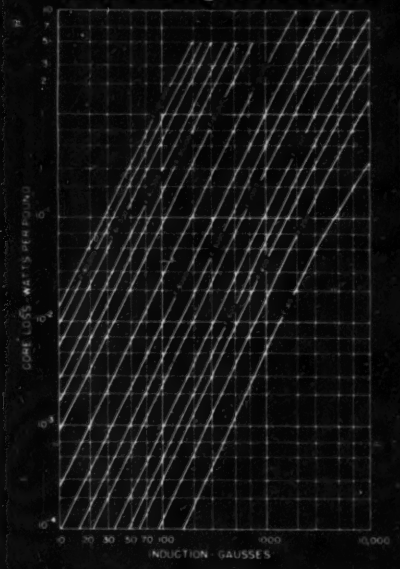
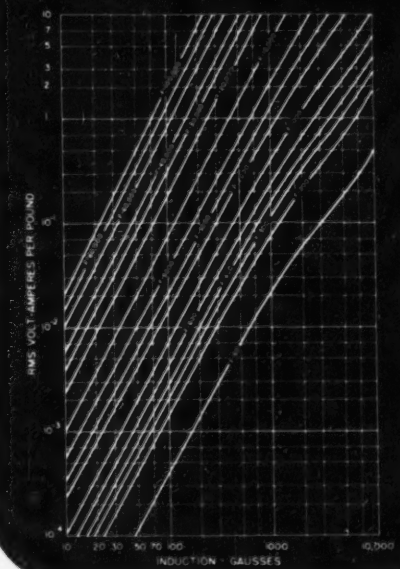


FIG. 4—Amplifier phase-shift frequency modulator

Tests at 100,000 cycles a second

Core loss and excitation characteristics of .002" high quality ARMCO Thin-Gage Electrical Steel.





show top magnetic properties of this .002" steel

Operating advantages of the newest grades of Armco Thin-Gage Electrical Steel for high-frequency equipment are demonstrated by a series of tests made in Armco's Research Laboratories.

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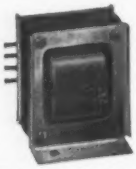

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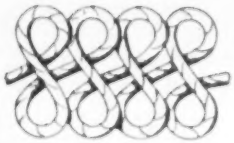

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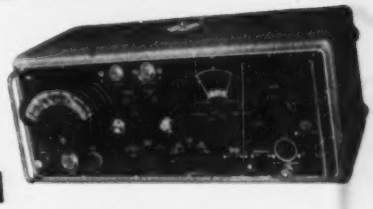

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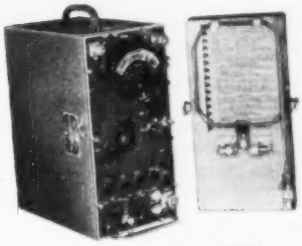

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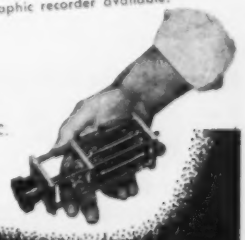

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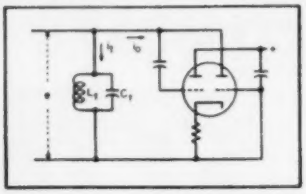


FIG. 5—Negative conductance oscillator

phase-reversing function a cathode-coupled positive-feedback amplifier is connected across the tank circuit (Fig. 5), where it behaves like a negative conductance and maintains oscillations so long as the positive conductance across the circuit does not exceed $g_m/2$, where g_m is the mutual conductance of each triode.

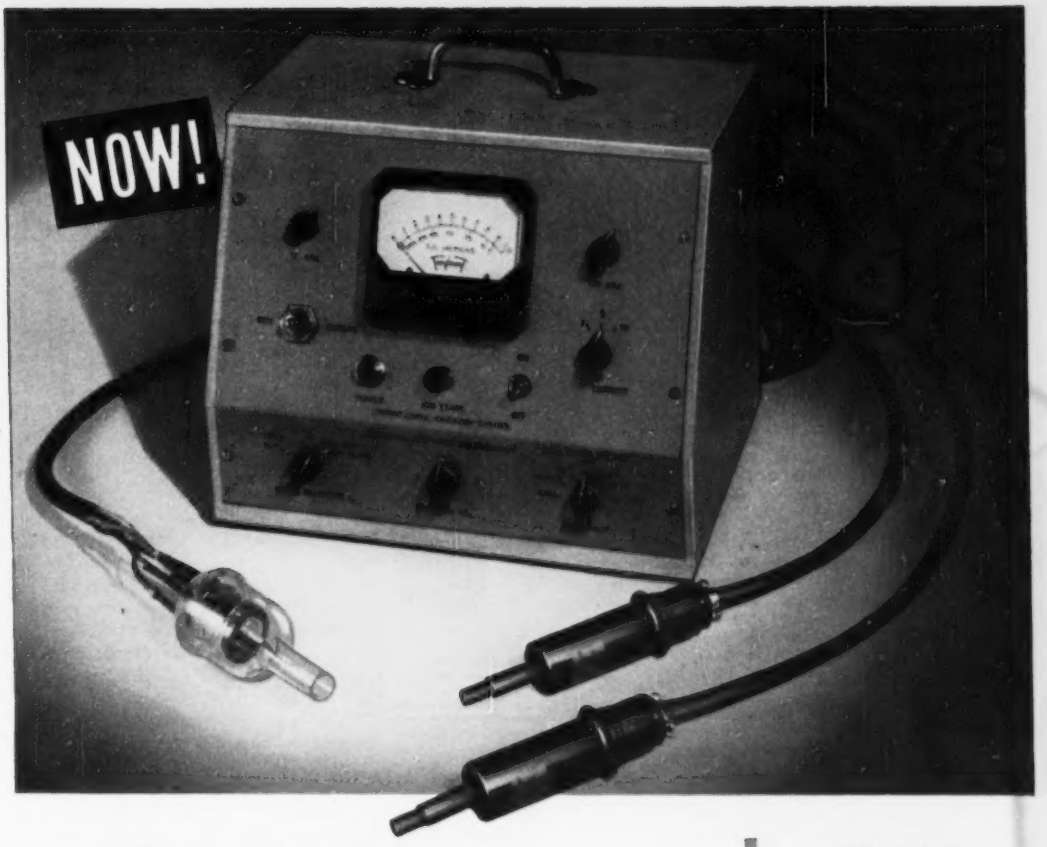
As mentioned earlier, the r-f voltage on the grid of the modulator must be small compared with the grid bias. This means about 1 volt peak to peak for low-capacitance tubes such as the 6AK5 and 6AH6. At the highest frequency, the gain of the phase-shifting amplifier is about 0.5, so the oscillator voltage should be limited to about 0.7 volt rms. This may be done very conveniently by shunting the tank coil with a crystal diode suitably biased back to act as a clipper.

Final Design

The final circuit is quite practical. The two cathode followers feeding the grounded-grid amplifiers for the oscillator and the modulator have been combined to simplify wiring and save a cathode choke. To reduce the amount of clipping by the diode, and so avoid undue generation of harmonics, the oscillator amplifier bias has been increased until oscillations are only just maintained over the whole range. A 6AH6 was chosen for the modulator because its grid characteristic gives rise to a more linear frequency-voltage relationship. It also gives a slightly wider deviation than the 6AK5.

Tank inductance L_1 consists of 52 turns of 34 g. enamelled copper wire, wound 30 turns per in. on a ½-in. diameter polystyrene former, with a 1-in. long iron dust core located at about the center of the winding. The inductance is about 16μh, and the self-capacitance of the order of 1 $\mu\mu$f.

The cathode choke has an in-



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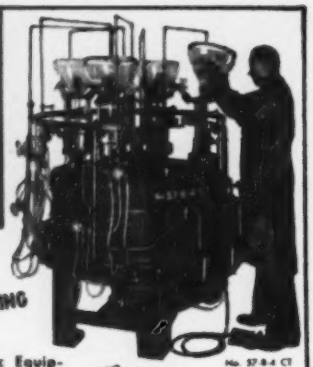

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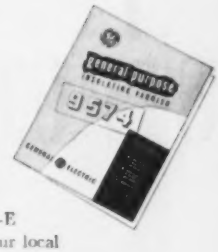

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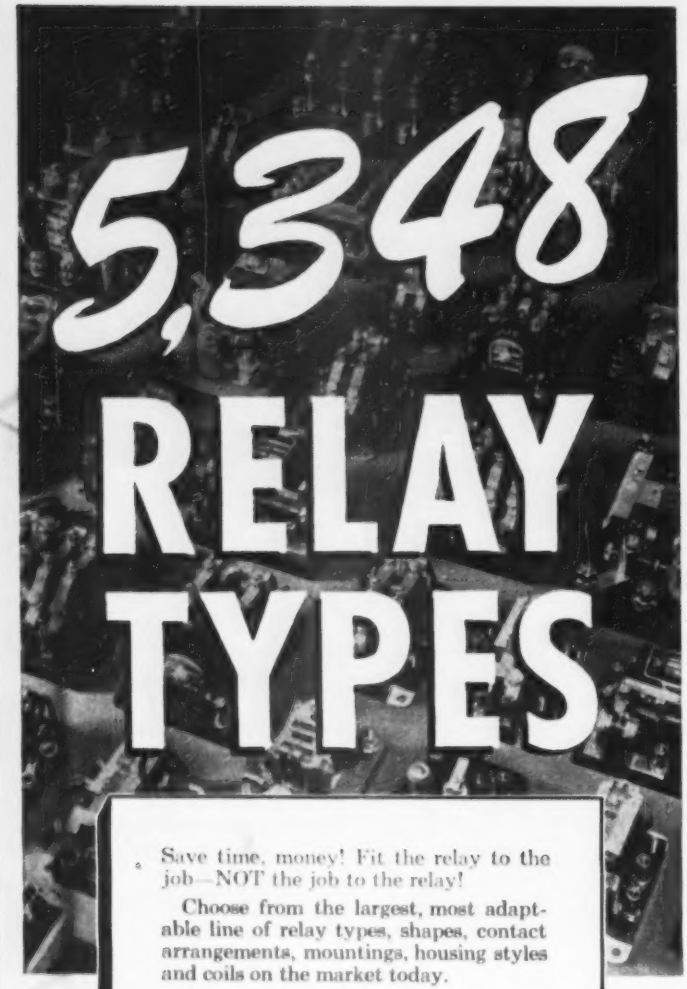

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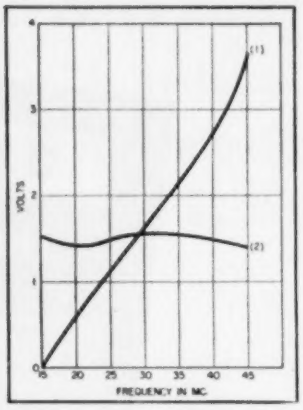

FIG. 6—Frequency plotted against modulation input voltage is shown by curve 1. Curve 2 is peak r-f output voltage plotted against frequency

ductance of about 6 μh and consists of three interleaved windings, each of 100 turns of 28 g. enamelled copper wire, wound on a ¾-in. diameter bakelite rod 3-in. long. The two heater leads were first close wound side by side on the first layer, then the cathode lead was wound on a second layer between the other two wires. Like the tank inductance, this choke should have as high an inductance as is consistent with low self-capacitance, but the problem is complicated by the requirement of low resistance for the heater leads.

The circuit is constructed on a bakelite panel to reduce stray capacitance. The frequency of this oscillator is dependent to a rather large extent on the supply voltage, so that a stabilized power supply is indicated, particularly if small frequency deviations at modulation frequency other than that of the line are to be a requirement.

The three-tube unit shown will cover the range 10 to 50 mc and if an output voltage of only a few millivolts is required, this may be obtained from the 5-ohm resistor in the anode of the cathode follower. If a higher output is required it is least disturbing to the operation of the circuit if the output is taken from the cathode of the cathode follower, but even there a load of 5 $\mu\mu$f reduces the sweep by several megacycles. The voltage at this point varies considerably with frequency, falling to minimum at

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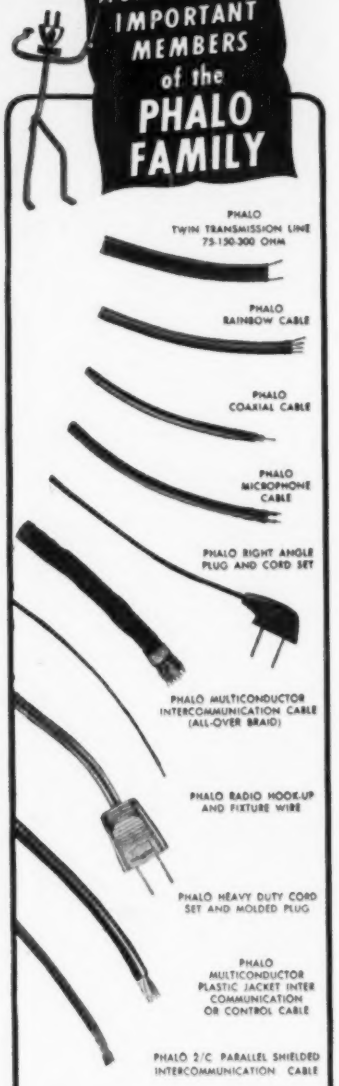
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about 20 mc and rising to about two or three times that value at the high and low-frequency ends of the sweep. This is due to the fact that at high frequency, the cathode-ground capacitance of the cathode-coupled amplifier causes a phase lag over and above that at the grid of the modulator, resulting in a negative conductance component of modulator admittance.

In the model constructed, a two-stage cathode-coupled amplifier, which has a falling output above 20 mc and which is low-frequency compensated by means of a series-tuned filter in parallel with the cathode load of the first stage, is fed from the cathode of the oscillator. The output is about 1 volt rms with a variation of less than ± 0.05 volt from 15 to 45 mc as shown in Fig. 6.

The frequency limits are from a minimum of 10 mc when the modulator is cut off to 50 mc at which point instability sets in, but the frequency variation is seriously nonlinear near the extremes. The usable range depends on the degree of linearity demanded. The curve of frequency against modulation voltage between 15 and 45 mc is shown in Fig. 6, and it may be seen that from 15 to 40 mc it is linear to within ± 250 kc or ± 1 percent, and the whole range shown is sufficiently linear to be useful for most purposes.

Acknowledgement is gratefully made to J. S. Foster, Director of the McGill University Radiation Laboratory, for the opportunity of working on this project, and to R. W. Jackson of the above laboratory for helpful discussions during the course of the work.

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(2) G. C. Saikiai and A. C. Schroeder, Cathode-coupled Wide Band Amplifiers, *Proc. IRE*, p 701, Oct. 1945.

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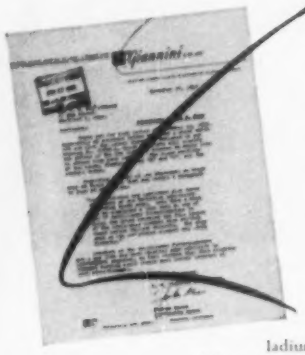

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- Dual outputs for feeding two 75 or 100 lines
- Black positive or Black negative output
- Resolution greater than 600 lines

INPUT: Vertical and Horizontal Driving pulses, Camera and Kinescope Blanking Pulses.

OUTPUT: Composite Video Signal, 3 Volts, 100 ohm line 115 volts 50/60 cps. Complete with tubes and including high and low voltage power units.

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Polarad *Electronics Corporation*

Television engineers and consultants to the nation's great television stations.

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PARTS

Cost less when made by

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The economy way to get a million small parts similar to these —

Examine the tubular and solid metal parts shown here twice size. If you use anything similar . . . in quantities of over a million . . . important savings can be yours. Send us the part and specs. Our quotation will show why the Bead Chain Company's MULTI-SWAGE Process has long been known as the most economical method of making electronic tube contact pins, terminals, jacks and sleeves. And, why more and more users of mechanical parts (up to ¼" dia. and to 2" length) employ our facilities. WRITE for Data Bulletin.

THE BEAD CHAIN MANUFACTURING CO.,

Tr. Mark 88 MOUNTAIN GROVE ST., BRIDGEPORT 5, CONN.

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Selenium Solves a Problem for the IBM problem solver

In building this complex problem solver, IBM chose Rectox Selenium Rectifiers. Thus, power supply maintenance is "just a memory" now on the IBM electrical brain.

Selenium rectifiers need little attention . . . require no periodic lubrication . . . have no rotating parts to wear and replace. You can install them in your equipment and forget them.

In addition, high-voltage selenium cells open the door to savings through cell reduction. Higher voltage cells (24 volt, d-c / 33 volt, rms compared to conventional 20 volt, d-c / 26 volt, rms) cut the number of cells required. And fewer cells mean lower costs.

Maybe you have a similar problem. Our engineers will be glad to work with you to find an economical answer. Get a copy of DB-19-025 from your local Westinghouse representative. Or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

J-21590

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RECTIFIERS AND CHARGERS
FOR ALL INDUSTRIES

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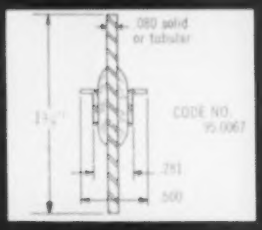
Announces

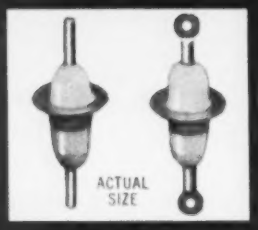
a LOW-COST

High-Performance

KOVAR-GLASS

SEAL



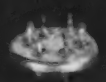


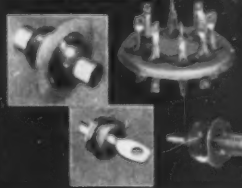
Here is a well-made, dependable, low-priced Kovar-Glass Seal, with the following highly desirable features:

- Easy to Assemble
- Mechanically Strong
- High Flashover Voltage
- High Thermal Shock Resistance
- Attractive Appearance
- Immediate Shipment
- Low Cost

Write for Samples and Prices Typical Stupakoff Kovar-Glass Seals

A CHARTER ADVERTISER IN ELECTRONICS





STUPAKOFF

CERAMIC & MANUFACTURING CO.

LATROBE, PA.

weighs eight pounds.

A complete system comprising a camera and viewing monitor consists of only the camera and one other unit, the master control monitor unit weighing 58 pounds. It is 26 inches long, 26 high and 8½ inches wide. The two units are interconnected by a multiwire cable that handles video and sweep voltages in addition to power. Similar equipment used by television engineers on remote pickups and employing an image orthicon weighs 800 pounds and consists of five units.

The monitor unit of the industrial system contains all power supplies and sweep generators, a total of 42 tubes. A seven-inch picture tube is also mounted in the monitor. The 60-cycle line is employed for vertical synchronization. Multivibrators count down from the 31.5-kc horizontal oscillator for comparison with 60 cycles.

The camera unit contains two tubes, a 6AG5 and a 12AT7 to handle the video signal fed to the low-impedance line. A considerable portion of the bulk of the small camera unit is taken up by a motor which mechanically focuses the lens. Control of focusing is done at the monitor where the image is viewed.

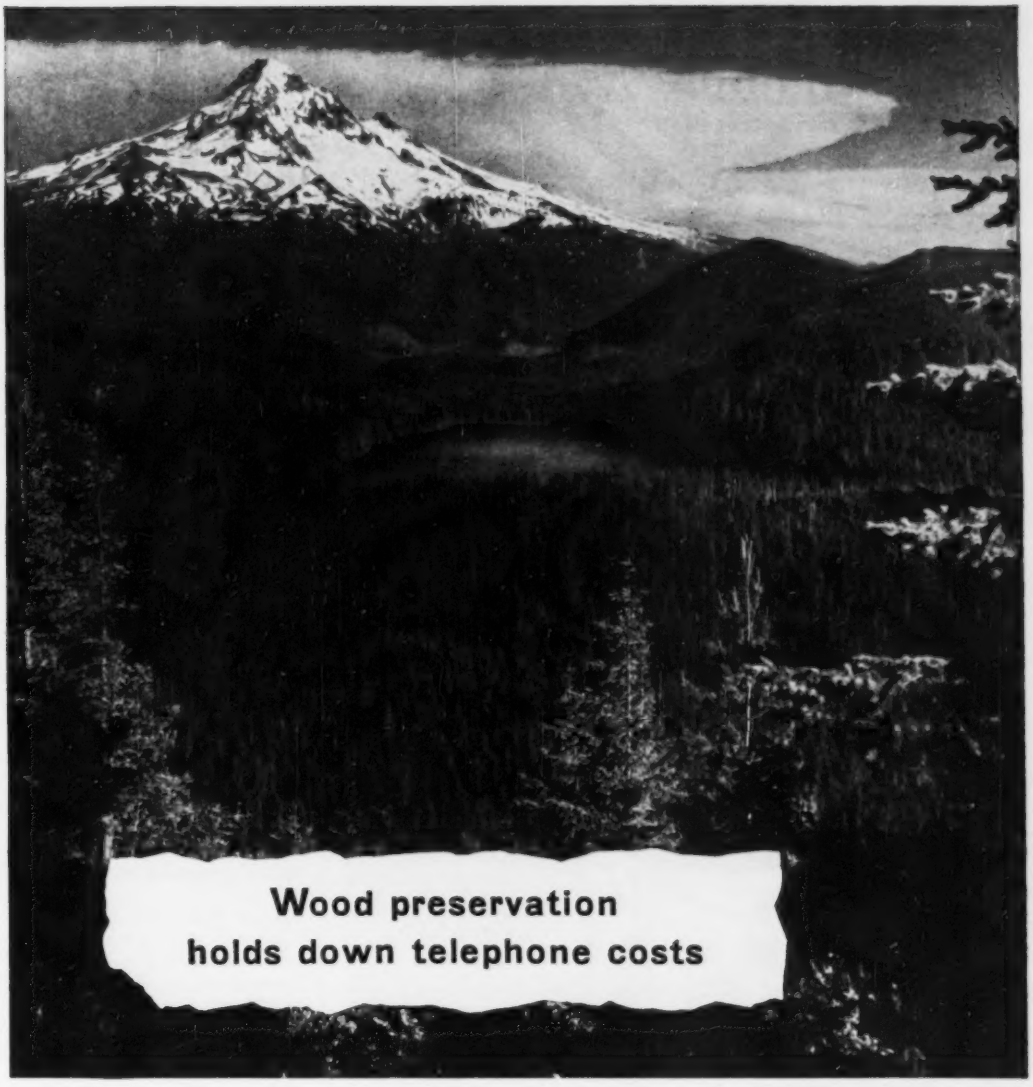
A conventional RMA standard video signal is produced by the equipment and this feature allows use of mass-produced home receivers to be used as extra monitors. Estimated cost of a typical installation is $6,500. The vidicon is expected to be priced at about one-fifth that of the image orthicon.

Recording Mass Spectrometer

PROGRESS in semiautomatic and automatic methods of analyzing gases, liquids, and solids has increased in rapid strides during the past few years.

The new recording mass spectrometer is an excellent example of modern analytical tools. The versatility of the instrument permits highly varied applications in the petroleum, chemical, rubber and associated process industries and nuclear energy laboratories.

As denoted by its name, the mass



Wood preservation holds down telephone costs

Poles are a substantial part of the plant that serves your telephone; making them last longer keeps down repairs and renewals that are part of telephone costs. So Bell Laboratories have long been active in the attack on wood-destroying fungi, the worst enemies of telephone poles.

Better, cleaner creosotes and other preservatives have been developed in co-operation with the wood-preserving industry. Research is now being carried out on greensalt—a new, clean, odorless preservative. Even the products of atomic energy research have been pressed into service—radioactive isotopes are used to measure penetration of fluids into wood.

Treated poles last from three to five times as long as untreated poles. This has saved enough timber during the last quarter century to equal a forest of 25,000,000 trees. More than that, wood preservation has enabled the use of cheaper, quickly growing timber instead of the scarcer varieties.

This and other savings in pole-line costs, such as stronger wires which need fewer poles, are some of the reasons why America's high-quality telephone service can be given at so reasonable a cost. It is one of today's best bargains.

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Exploring and Inventing, Devising and Perfecting, for Continued Improvements and Economies in Telephone Service.

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"HEAD AND SHOULDERS" ABOVE THEM ALL!

UNBRAKO Socket Head Shoulder Screws with *Knurled* Heads . . . are preferred by die-makers everywhere . . . but are useful for many machine applications. Their knurled heads provide a slip-proof grip—even if fingers and heads are oily or greasy—thus materially speeding production.

UNBRAKO Shoulder Screws are available in full range of standard sizes—other sizes to special order.

Write for further details, today.

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JENKINTOWN 10 PENNSYLVANIA

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For Instrumentation and other critical applications

TYPE BX—1 WATT

NON-INDUCTIVE

MAX. RES: 1.5 Megohm (331 Alloy) 1.0 Megohm (Nichrome) 10,000 Ohms (Manganin)
BODY SIZE: 1" lg. by 9/16" diam.
TOLERANCE: STANDARD 1% (TO 1/10% at Slight Extra Cost)

TYPE CX—½ WATT

NON-INDUCTIVE

MAX. RES: 750,000 ohm (331 Alloy) 500,000 ohm (Nichrome) 15,000 ohm (Manganin)
BODY SIZE: 5/8" lg. by 9/16" diam.
TOLERANCE: STANDARD 1% (TO 1/10% at Slight Extra Cost)

IN-RES-CO wire wound resistors are engineered for the manufacturer maintaining a reputation of top quality and performance in his equipment. They cover a full range from 1 watt to 10 watts and .01 ohm to 1.5 megohm. Conservative ratings assure maximum long life; trouble free service. Write for catalog today on company letterhead.

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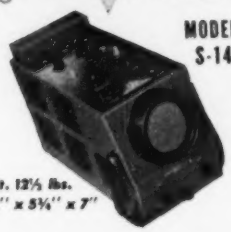
BY WATERMAN

MODEL S-14-A



Wt. 12½ lbs.
12" x 5¼" x 7"

A portable oscilloscope engineered to the exacting requirements of the electronic designer . . . a precision instrument that sacrifices nothing in performance characteristics or dependability because of its portable size or budget price . . . A giant in performance, a midget in size, the S-14-A POCKETSCOPE invites critical comparisons!

Identical Vertical and Horizontal channels with 10 mv/in sensitivity, response from 0 to 200KC within —2DB . . . Non frequency discriminating attenuators and gain controls . . . Internal calibration of trace amplitude . . . Linear time base oscillators with ± sync for either repetitive or trigger sweeps, from ½ cycle to 50KC . . . Trace expansion . . . Filter screen . . . Mu metal shield . . . and a host of other features.

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S-14-B	WIDE BAND	POCKETSCOPE
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Also, RAKSCOPES, Linear Amplifiers, RAYONIC tubes and other equipment.

NEW MANUALLY-OPERATED "STICK" WINDER GETS "ELECTRICAL MANUFACTURING" DESIGN AWARD - UNIVERSAL NO. 108

A fully automatic coil winding machine pays its way only when the runs are long enough to justify the expense of the set-up time required.

Since many coil lot sizes are small, only a portion of the market requirements can be filled economically by the use of automatic machinery.

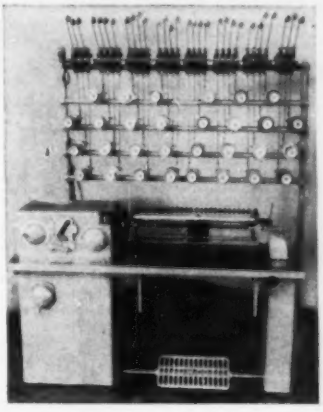
This situation, together with the obsolete condition of many of the manually-operated winders in the electrical and electronic parts industries created the necessity for developing a manually-operated winder of *modern* design to supplement the automatic type.

No. 108 COIL WINDER

The No. 108 Coil Winder was developed by the Universal Winding Company to meet the demand for a modern manually-operated machine to wind paper-insulated coils in multiple or "stick" form.

Its design received an Honorable Mention Award in the 11th Annual Product Design competition sponsored by "Electrical Manufacturing."

The objective of Universal engineers was to produce an integrated unit, clean and functional, with labor-saving features which would warrant replacement of present equipment, and with a selling price low enough to be attractive to the predominantly "job shop" type of market characteristic of the ever-changing electrical and electronic parts industries.

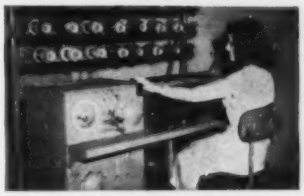


No. 108 Coil Winder.

After extensive field surveys and an analysis both of suggestions made by electrical engineers, superintendents and operators, and of their criticisms of existing machinery, our engineers determined upon the basic principles for the 108 Coil Winder that are incorporated in the following outstanding features.

Quick Set-Up All machine functions are built around the idea that quick set-up and finger-tip control are the best means of creating savings in the use of skilled labor during machine set-up.

Flexibility The machine can be adjusted quickly to accommodate changing requirements of wire size, coil length and diameter.



Note convenience of controls.

Accessibility Operations involved in preparing and finishing coils vary from job to job, but access to the coil stick is completely unhampered and all coils are readily processed. Accessibility features are also provided for ease of maintenance and adjustment.

Simplicity Since operators of this type of machine are usually women and may be disturbed by any complexity of controls and adjustments, the simple external appearance of this machine promotes confidence.

Cost Compared with an automatic machine winding the same type of coils, the cost of this machine is very modest, considering its efficiency and the high quality of its construction.

Bed The bed is a single casting, extending the full length of the machine, and is of aluminum to cut down weight. The supporting columns are made of single steel sheets, formed and welded and are braced at the bottom by steel straps which serve as feet. The left-hand one houses the motor and drive mechanism and the right-hand one is a cupboard for the operator's personal belongings.

For free literature on design features, write for "Getting the Most from Coil Winding No. 14."

UNIVERSAL WINDING COMPANY

P. O. Box 1605 Providence 1, R. I.

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FOR WINDING COILS IN QUANTITY ACCURATELY . . . AUTOMATICALLY USE UNIVERSAL WINDING MACHINES

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MODEL ON-5

For only

$485.00

this new five-inch Browning 'scope gives you the basic laboratory equipment for pulse work — in a single, compact unit with:

- **Triggered sweep** rate continuously variable from 1.0 to 25,000 microseconds per inch.
- **Sawtooth sweep** rate 10 cycles to 100 KC.
- **Sweep calibration** (triggered and sawtooth) in microseconds per screen division accurate to ±10%.
- **Vertical amplifier flat** within 3 db. from 5 cycles to 5 megacycles.
- **Sensitivity** 0.075 volts RMS per inch.
- **Horizontal amplifier** d.c. to 500 KC, sensitivity 2 volts per inch.
- **Self-calibrating** on both X and Y axis.
- **Readily portable** . . . weighs but 50 pounds.

plus these ELECTRICAL and MECHANICAL features

• 5UP1 cathode-ray tube operates at accelerating potential of 2600 volts • Sweep starting time is approximately 0.1 microsecond • Sweep may be triggered or synchronized by positive or negative sine-wave or pulse signals of 0.5 volts (external) or 0.75 inches deflection (from vertical amplifier) • Three-step attenuator — 100:1, 10:1, and 1:1, plus continuous adjustability over entire range • Peak-to-peak vertical calibration voltages of 0-2-20-200 at accuracy of ± 10% • Cathode connection, brought out to front panel, allows external blanking and marker connection • All deflection plates are available for direct connection • Steel cabinet finished in black wrinkle • Steel panel finished in black leatherette • Copper-plated steel chassis with lacquer finish • Controls grouped by function for operating convenience • Free-view screen has graduated X- and Y-axis scales • Size: 10" wide, 14½" high, 16¾" deep • Instrument draws 180 volt-amperes at 115 volts 60 cycles.

NET PRICE, F.O.B. Winchester, Mass.....$485.00

FREE BULLETIN gives further data on this new, low-cost, versatile oscillosynchroscope. Ask for data sheet ON-54E.

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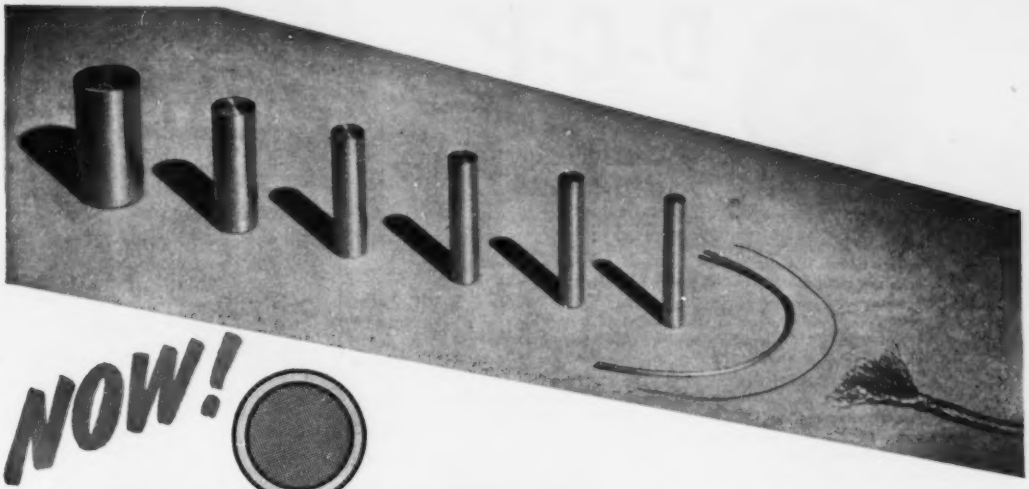
ENGINEERED FOR ENGINEERS

Panel of new G-E mass spectrometer showing Electronik strip chart recorder

spectrometer analyzes a gaseous mixture first by ionizing the gas and then by sorting these ions according to their mass. The sample to be analyzed is admitted in the form of neutral gas molecules to the spectrometer. The gas molecules are fed into the ionization chamber at low pressure from an expansion volume through a leak so as to obtain a constant flow without discrimination into the spectrometer tube where a high vacuum is maintained by continuous pumping.

In the ionization chamber, some of the gas molecules of each constituent are converted to positively charged ions as a result of colliding with electrons emitted by the heated filament. Other neutral molecules which are not affected by the electric field in the chamber are withdrawn by an exhaust pump. The ionized molecules are accelerated by high voltage and focused into a beam which passes through the narrow collimating slit into a region within the spectrometer tube where no electric field exists.

In the spectrometer tube, the ion beam is deflected by the varying magnetic field which causes ions of specific mass to follow orbital paths of a certain radii. With the magnetic field at a certain known intensity, ions with a particular specific mass follow a definite path through the magnetic field and pass



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Combining toughness and corrosion-resistance of *Nickel* with the superior conductivity of *copper*

For many years electrical designers and maintenance men have been looking for a really *tough* conductor . . . one able to withstand abusive conditions, yet having good electrical characteristics as well.

Now, thanks to the technical skill of the Alloy Metal Wire Co., Inc., Prospect Park, Pa., such a conductor is available.

The outstanding advantages of Nickel-clad copper conductor are strength, corrosion-resistance, and resistance to high-temperature failure. Its electrical conductivity is 70% that of copper alone.

Among the many applications where Nickel-clad copper conductor is being used with outstanding success are: lead wires for electronic tubes, heating appliances, infra-red ovens, resistance and induction furnaces. It is also used for special power lines, fixture wiring in corrosive atmospheres and spark plug electrodes.

For electronic tube uses in particular, Nickel-clad copper wire offers many important advantages. It provides excellent conductivity for uses where exposed copper is not desirable. It does not oxidize, flake, or embrittle under the high temperatures encountered during stem making, sealing and exhausting. Welds are strong and flexible. Nickel-clad copper wire can be welded to molybdenum and tungsten as well as to itself.

Nickel-clad copper conductor is available in rods from ⅛ in. to .031 in. diameter; and in round and flat wire, coils or spools, solid or stranded, in all commonly used sizes.

If you would like to try this new conductor, write directly to Mr. Dave Schmid, Alloy Metal Wire Co., Inc., Prospect Park, Penn. He will send samples of the type you require.

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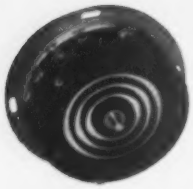

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*DIFFERENTIAL COMPUTING POTENTIOMETER

NOW—add or subtract two variables in one instrument—with one voltage source! This compact unit does work of two potentiometers—saves cost by eliminating one—has high inherent accuracy of a single potentiometer.

When one variable rotates shaft and other rotates body of this Type 748 Potentiometer, net voltage sum or difference is brought out through coin-silver precision slip rings in cover plate, shown above.

Linearity of 0.10% is guaranteed—and the high resolution, long life, low noise level, and low torque found in all Fairchild Precision Linear Potentiometers can be depended upon as always.

Suggested applications for this new precision instrument include use in servomechanisms for computing or power amplification, direct replacement of 2 single potentiometers when one is being used for compensation or correction purposes, etc. For details, address: Dept. N, 88-06 Van Wyck Boulevard, Jamaica 1, N. Y.

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X-VAR is non-corrosive, non-creeping—leaves wire ready for soldering. Now in use by leading manufacturers of electrical products. *Write for FREE SAMPLE for testing.*

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LEDEX
RELAYS and CIRCUIT SELECTORS
ROTARY SOLENOID OPERATED

- REMOTE CONTROL
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for REMOTE CONTROL of MULTIPLE COMPLEX CIRCUITS

Many versatile designs of stepping, counting, adding and subtracting, latching, and *circuit selecting* relays are made possible by the combination of the Ledex Rotary Solenoid and wafer type rotary switches. Self-stepped or externally impulsed, the device is immediately adaptable to many remote control applications. A choice of wire sizes permits a wide range of operating voltages and power requirements. Various types of mountings further increase its adaptability. In addition to its positive control of multiple, complex circuits, a reserve of mechanical power is available for the performance of duties other than switching operations.

We supply to quantity users and solicit the opportunity to be of assistance in solving multiple circuit relay problems.

WRITE DIRECT TO
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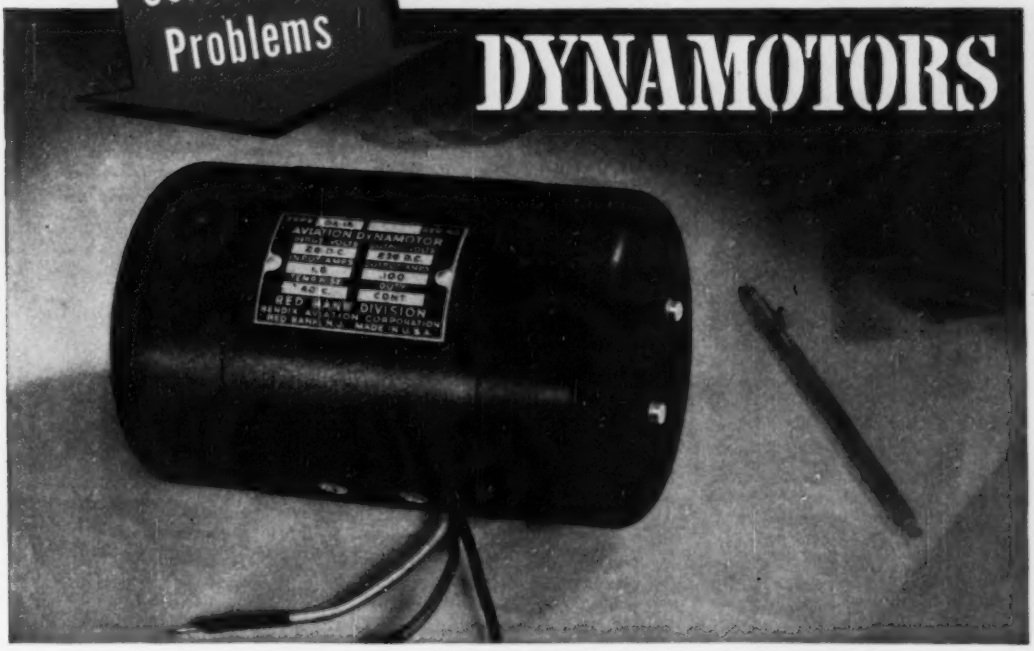
Let *Bendix* Solve Your Problems

SPECIALIZED DYNAMOTORS



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Bendix dynamotors are built to supply the *exact* power requirements of your equipment—to work from any input voltage and to deliver the necessary power at any output voltage. Dual or triple output voltages are available for high and low-level portions of the circuit, or for biasing. For critical circuits, regulated outputs will simplify your design problems, especially since a regulated filament supply can be obtained as a bonus when regulating the high voltage output. Bendix will build your dynamotors to the usual military specifications or to meet even more rigid requirements, such as operation at higher temperature, or altitudes in experimental equipment.

Samples or production units of special dynamotors are priced competitively. A definite proposal will be made upon receipt of the details of your problem. For immediate information call our Engineering Staff—Red Bank 6-3600, Red Bank, New Jersey.

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- Sizes—2¾" to 5¼" diameter
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TUBES AT WORK (continued)

Operator introduces gas sample into analytical mass spectrometer. After sample system has been evacuated, a low pressure of the gas is led into a measured volume of the system and provides for the mass-spectrometric analysis of the unknown gas

through a narrow collector slit to reach the collector plate and produce a measurable electric current.

As the magnetic field intensity is varied by changes in the current through the magnet, the mass spectrum is scanned. By correlation of changes in magnet current with movement of the Brown recorded chart, the time divisions of the chart indicate the mass numbers being measured. To adjust automatically the sensitivity and speed of the recorder for optimum recording of each mass peak, a precollector circuit is employed.

The precollector circuit includes a precollector which comprises a fine wire electrode. This electrode collects ions of the mass number under measurement prior to their passing through the collector slit to the collector plate. The current from this electrode, therefore, constitutes a preliminary measurement of the abundance of the mass which is about to be measured.

Circuits in the recorder respond to mass and its abundance before measurements so that the recorder can be automatically adjusted.

The General Electric recording mass spectrometer provides an extremely wide scanning range. With a fixed geometrical arrangement of spectrometer tube and collector electrodes, the specific mass is proportional to the square of the magnetic field strength, and inversely

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● Extremely fine tungsten wire (as small as .0002) can now be supplied in quantity and at reasonable price. While this wire is of extremely small diameter, tensile strength is surprisingly high, size is uniform and surface condition excellent.

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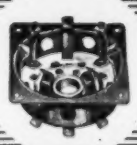
LOW LOSS AT VHF



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122-101 Tube Socket

An absolutely secure mounting for tubes with medium molded flare 7 pin bases. For mobile applications or fixed station use the 122-101 is more than a socket, it is a basic sub-assembly. Provisions are made for mounting button mica capacitors directly on the socket. Grid terminals are designed to accommodate VHF grid tank components. A ventilated aluminum base shield recesses socket below the chassis.

Steatite insulation and silver plated contacts permit Septar based tubes such as the 829, 832 and 4D32 to be operated at their high frequency limit. For further socket information write the leading producer of power tube sockets in the electronic industry.

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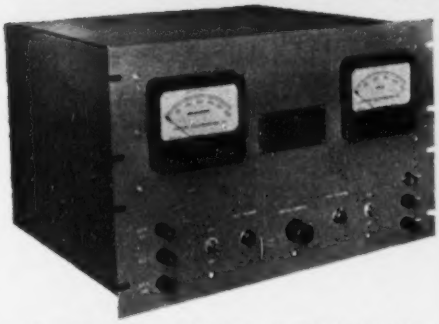
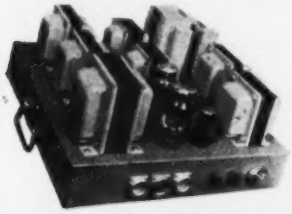
½% REGULATION! WITH THE NEW "A.E.C" REGULATED POWER SUPPLY UNITS



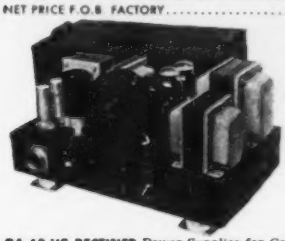
Left: **MODEL PSR-100**...30 to 500 volts D.C. at 0 to 300 ma. 6.3 volts A.C. center-tapped at 6 amp; ½% or better regulation under any conditions of operation within ratings. 10 MV. or less peak-to-peak ripple voltage. Output impedance effectively zero. High voltage continuously variable from 0 to 500 volts.
NET PRICE F.O.B. FACTORY.....$393.00

Right: **MODEL PSR-102**...200 to 1000 volts D.C. at 0 to 500 ma. 6.3 volts A.C. center-tapped at 10 amp; ½% or better regulation under any conditions of operation within ratings. 20 MV. or less peak-to-peak ripple voltage. Output impedance effectively zero. High voltage continuously variable from 0 to 1000 volts.
NET PRICE F.O.B. FACTORY.....$695.00

Above, right: **MODEL PSR-103**...200 to 400 volts D.C. at 0 to 200 ma. from each of two separately controlled outputs, or 200 to 400 volts D.C. at 0 to 400 ma. 6.3 volts A.C. center-tapped at 10 amp; ½% or better regulation under any conditions of operation within ratings. 10 MV or less peak-to-peak ripple voltage. Output impedance effectively zero. Output voltages continuously variable. NET PRICE F.O.B. FACTORY.....$693.00

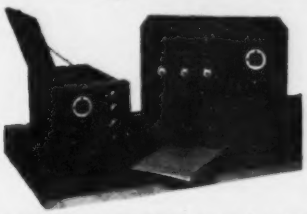


TCS POWER SUPPLY MODEL PS-106. Designed for use with U.S. Navy type TCS-1 thru TCS-12 transmitter-receiver for 110 or 220 volt A.C. applications. INPUT: 110/220 volts A.C. 50/60 C.P.S. OUTPUT: 400/450 volts D.C. at 200 ma. 225 volts D.C. at 120 ma. 12 volts D.C. at 1.5 amp. 12.6 volts A.C. at 4 amp
NET PRICE F.O.B. FACTORY.....$200.00



RA-62 VG RECTIFIER Power Supplies for Ground Station Operation of SCR 522 VHF Radio. SPECIFICATIONS: INPUT: 110/120/220/240 volts A.C. 50-70 cps. 225 watts. OUTPUT: 300 volts D.C. at 300 ma. 150 volts D.C. at 30 ma. 13 volts D.C. at 4.4 amp.
NET PRICE F.O.B. FACTORY.....$138.00

TEST EQUIPMENT FOR AIRCRAFT INSTRUMENT LANDING SYSTEMS

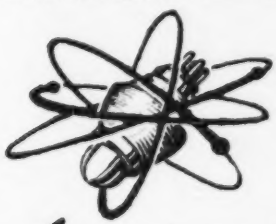


TS/67-C ILS SIGNAL GENERATOR...A crystal-controlled RF signal generator for sensitivity measurements and alignment of glide path and localizer receivers. Frequency coverage: 332.6, 333.8, 335, 108.3, 108.7, 109.1, 109.5, and 110.3 mcs.
NET PRICE F.O.B. FACTORY.....$1,100.00

TS/170-C GLIDE PATH TEST SET...Battery operated portable test oscillator which provides a crystal-controlled signal at 332.6, 333.8 or 335 mcs., which may be 30% modulated from an internal source at 90, 150, 1000 cps. or unmodulated as desired, for glide path channels GX, GY, and GZ.
NET PRICE F.O.B. FACTORY.....$190.00

TS/173-C LOCALIZER TEST SET—*Left*...Battery operated portable test oscillator which provides a crystal-controlled signal at 108.3, 108.7, 109.1, 109.5, 109.9, or 110.3 mcs., which may be 30% modulated from an internal source at 90, 150, 1000 cps. or unmodulated as desired, for localizer channels U, V, W, X, Y and Z.
NET PRICE F.O.B. FACTORY.....$200.00

MB-2 MARKER BEACON TEST UNIT—*Right*...A crystal controlled, portable, 75-megacycle transmitter whose output may be tone-modulated at 400, 1300 or 3000 cycles per second, as desired.
NET PRICE F.O.B. FACTORY.....$140.00



American Electroneering Corp.

Additional information, all units, available on request.

2112 South LaBrea Avenue · Los Angeles 16, California

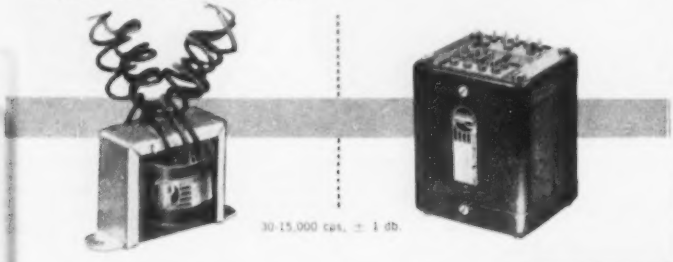
Telephone: WEbster 3-5829

Cable: AMETRONEER Teletype: L.A. 641

Peerless Performance

RMA 70 Volt Line Matching Transformers

Complete coverage from ¼ to 64 watts, with an insertion loss less than 0.6 db at full power, makes the Peerless 70 volt line the best buy for RMA-standardized sound distribution systems! Available in three sizes (¼-4, 3-24, 8-64 watts), each provides five primary taps for overlapping coverage through entire power range in steps never greater than 3 db. Five secondary impedances match speakers of 2 to 16 ohms, singly or in combination. Because efficiency is high, these transformers will stand considerable abuse and may be safely up-rated with only a slight reduction in frequency range and efficiency. Furnished potted or in open frames. Mounting flanges provided.



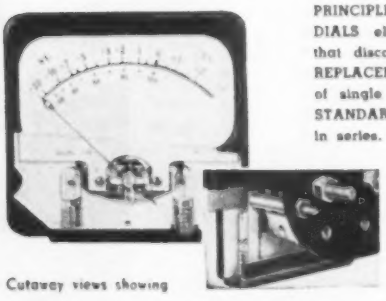
30-15,000 cps, ± 1 db.

PEERLESS ELECTRICAL PRODUCTS
DIVISION
6relative N. VINE ST., HOLLYWOOD 38, CALIF. • 161 SIXTH AVE., NEW YORK 13, N. Y.

ALTEC
LANSING CORPORATION

New! Burlington
ILLUMINATED INSTRUMENTS

EXCELLENT LIGHT DISTRIBUTION affords **EASE in READING. GLARE REDUCED** to a minimum by retaining **COMPACT DESIGN** of front case extension. **REFLECTED LIGHT PRINCIPLE** permits use of standard **METAL DIALS** eliminating translucent materials that discolor with age and use. **BULB REPLACEMENT FACILITATED** by removal of single lamp assembly. Two 3.8 volt **STANDARD BULBS** are used and connected in series.



Cutaway views showing positions and connections of lamp assembly.

Available in all ranges 3½" and 4½" rectangular semi-flush models. Write Dept. F-50 for complete details.

BURLINGTON INSTRUMENT COMPANY
BURLINGTON, IOWA

Tungsten and Molybdenum Metals

FOR THE ELECTRONICS & ELECTRICAL INDUSTRIES

TUNGSTEN

Wire ● Rod for Contacts
Rod for Valve Seals and Supports
Electrodes for Therapeutic Apparatus
Atomic Hydrogen Arc Welding Rods
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MOLYBDENUM

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We also supply Tungsten, Molybdenum and Tantalum Metal Powders, Titanium Hydride, Zirconium Hydride and many other metallurgical products.

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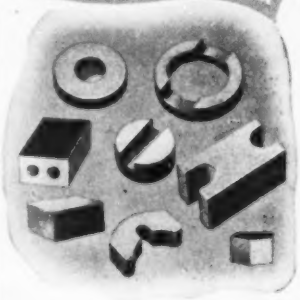
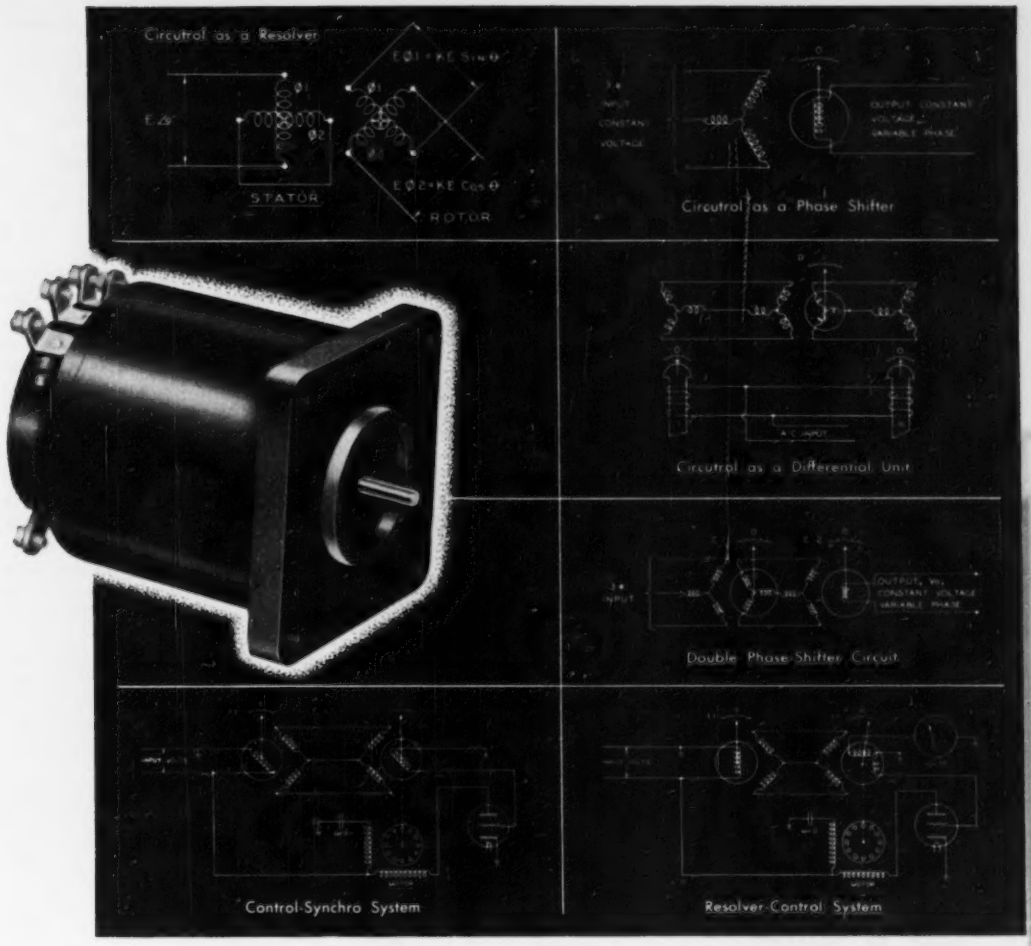


Small physical size and high efficiency. Available in a wide range of sizes and shapes for the Electronics Industry.



For Electronic Computation

Kollsman Circutrol units offer a high degree of versatility as phase shifters, indicators and controllers. And when two or more are connected electrically, the solution of many complicated problems and functions is possible. These units are designed with high impedance windings to perform over a wide range of voltages and frequencies — characteristics that facilitate working them directly into any electronic circuit.

The Circutrol is but one of a complete line of miniature special-purpose AC motors engineered and manufactured by Kollsman Division, specialists for over twenty years in precision aircraft instrumentation and control. Each unit represents the solution to specific requirements. Among those available, you may find the exact answer to your control problems. If not, the experience and skill of Kollsman engineers may be called upon to produce units to your particular needs. For complete information, address: Kollsman Instrument Division, Square D Company, 80-64 45th Avenue, Elmhurst, N. Y.

KOLLSMAN INSTRUMENT DIVISION

SQUARE D COMPANY

ELMHURST, NEW YORK GLENDALE, CALIFORNIA

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the complete line for industry...

RCA-5819
Multiplier Phototube
for scintillation counters*

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Your local RCA Tube Distributor carries adequate stocks of dependable RCA electron tubes to meet virtually every industrial and laboratory requirement. Look to him for information and prompt service on the tubes you need.

*The RCA-5819 in a scintillation counter is at least *ten times more sensitive than a Geiger Counter* in the detection of gamma rays...and provides long reliable service. Readily adaptable to counting and allied equipment employing Geiger Counters. Suitable for many other applications involving the detection and measurement of nuclear particle radiation.

RCA **RADIO CORPORATION of AMERICA**

ELECTRON TUBES **HARRISON, N. J.**

proportional to the first power of the accelerating voltage. A mass range of 1 to 300 is readily obtained with automatic magnetic scanning. Higher masses to 400 can be measured by adjusting the accelerating voltage. The mass of an ion is the sum of its nuclear particles, for instance CO_2 has a mass of 44—C=12, O=16.

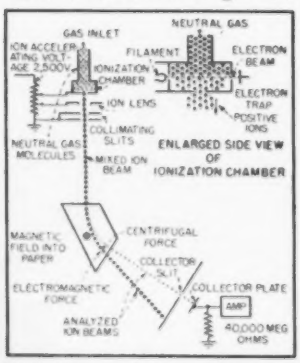
With the recording type of spectrometer, analytical results become apparent coincident with the scanning of the mass spectrum and the presence of any isotopes is revealed before the analysis is complete. The operator can reanalyze any portion of the mass spectrum immediately should results prove unsatisfactory and because analyses are recorded, notes can be made directly on the chart to facilitate later analysis.

The apparatus is provided with adjustable ionization potentials to permit separation of certain isomers. Samples can be in the gaseous, liquid or in certain cases the solid state. The automatic change of recorder sensitivity incorporated in the instrument prevents multiple traces on the mass spectrum record.

With the recording type of analysis, the average time required to record the mass spectrum from mass 1 to mass 100 is approximately 10 minutes.

The time required to scan depends upon the number of peaks because the recorder is automatically slowed down as each peak is being recorded. Full-scale peaks require about four seconds to be recorded.

A continuous indicating dial on



Block diagram of the complete instrument

COPPER ALLOY BULLETIN

PRODUCT IMPROVEMENT EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by Bridgeport Brass Co. "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*

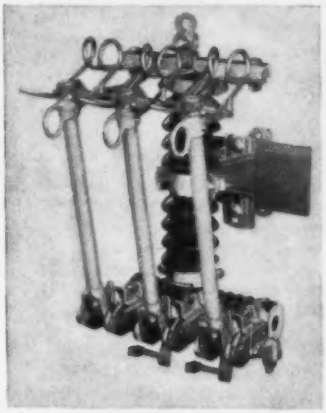
High Conductivity and Reliability Essential in Alloys for Power Transmission Equipment

Power distribution equipment made by Railway and Industrial Engineering Co., Greensburg, Pa., is designed for ruggedness and dependability. For this reason, materials are selected for high conductivity, excellent mechanical properties and resistance to corrosion.

All current-carrying parts are of copper and its alloys. Switch blades on the Type TTR are made from Bridgeport's high conductivity copper pipe, which has a conductivity better than 100% IACS at 68 deg. F soft.

In the type R3T horn gap switch, good spring properties and good conductivity are required. Bridgeport's Phono-Electric 840 was chosen to assure dependable high-pressure contact at all times. Phono 840 resists wear, corrosion and arcing, and is much stronger than copper, with 40% of copper's conductivity.

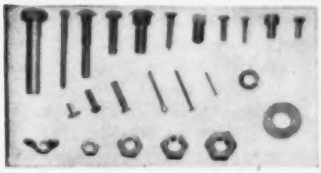
Phono-Electric 840 is also used in the Type TTL group-operated horn gap switch and the open type repeating cutouts, for dependable, high-pressure, good conductivity contacts. These applications are typical of the uses of Phono-Electric 840 Bronze in pole line and power transmission hardware, U-bolts, wire connectors, etc., where strength, toughness, good electrical conductivity and resistance to corrosion from weathering are required.



Open type repeating cutouts use Bridgeport's Phono-Electric No. 840. Courtesy Railway and Industrial Engineering Company.

Bridgeport's No. 609 Silicon Bronze for Dependable, High Strength Fasteners

The increasing demand for high strength, rust-free fasteners able to stand up over long periods of time without attention is being met by Bridgeport's No. 609 Silicon Bronze, developed about fifteen years ago by Bridgeport Brass Company. This alloy is used successfully for bolts, nuts, U-bolts, wire and cable connectors, nails, cotter pins, etc., for hardware on power transmission lines which are exposed to the elements and subjected to vibration in high winds or to heavy ice loads. Other uses are for electrified transportation systems and for the manufacture of building and marine hardware, etc.



High strength, corrosion-resisting Silicon Bronze screw products. Courtesy H. M. Harper Company.

Bridgeport's No. 609 Silicon Bronze (approx. 98% copper, 2% silicon), because of its fine corrosion resistance, high strength and other engineering properties, is finding increasing use where reliability is required and under conditions too severe for ordinary materials.

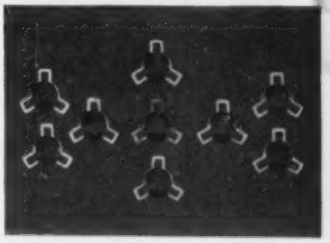
From a manufacturing standpoint, Bridgeport's No. 609 has fine workability. Its unusual malleability, even in the hard drawn condition, permits cold upsetting and roll threading operations for making cap and machine screws, nuts, bolts and similar screw products, with a great saving in the number of operations as well as reduction of scrap. When cold upset from hard drawn wire, screws can easily attain tensile strengths of about 100,000 lbs. per square inch. When properly made, they do not require heat treatment after upsetting.

No. 609 and other engineering alloys are described in Bridgeport's 128-page Technical Handbook, which also contains valuable information about other copper-base alloys, suggested applications, specifications and other data. A copy will be sent upon request.

632 Silicon Bronze Makes Dependable Spring-Type Bearing Retainer

One of the engineering features that contributes to longer life of Signal Universal Heater Motors made by Signal Manufacturing Co., Inc., Lynn, Massachusetts, is the accurate alignment of the sealed-for-life bearings. Proper line-up during assembly and under any deflections during operation is secured by seating the bearing in the spherical pocket of the motor case, where it is retained by a strong spring made of Bridgeport's Silicon Bronze 632.

This stiff spring provides the uniform pressure necessary for a tight, firm fit against the case pocket, and yet is resilient enough to allow for some motion during line-up. However, it must be strong enough to prevent any turning of the bearing, even at shaft speeds up to 10,000 rpm.



Bearing Retainers made from 632 Silicon Bronze used in fractional horsepower motors for automotive and marine heaters, defrosters, windshield wipers, etc. Courtesy Signal Manufacturing Co., Inc., Lynn, Mass.

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Established 1865

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Timing Ideas

A BEAR FOR PUNISHMENT

IF you're looking for a rugged, heavy duty interval timer, this Haydon® unit will save you time and money. It will meet every test for stamina, dependability and efficiency; is designed as a versatile, multi-purpose unit. Whatever your need for an interval timer may be, see the Haydon Series 8006 first.

CHECK THESE 8006 FEATURES

1. Standard models for intervals of 1, 15, 60 and 180 minutes; dial and knob optional. **2.** Other models for intervals up to 24 hours or more are available, without dial or knob. **3.** HOLD feature furnished if wanted. **4.** Heavy duty switch is rated 28A, 250 VAC; 1 HP 250 VAC. **5.** Heavy contact pressure; ample follow-through is assured. **6.** Snap action device gives quick, positive break. **7.** Removable dust cover for timer; totally enclosed motor. **8.** Settable in either direction, to start or when operating. **9.** May be used under conditions of high temperature and humidity.

ALL HAYDON TIMING DEVICES GIVE YOU

these advantages of the dependable Haydon Motor: Total enclosure — Very small size — Slow (450 rpm) rotor for long life, quiet operation — Controlled lubrication with separate systems for rotor and gear train — Mounting and operation in any position.

® TRADE MARK REG. U.S. PAT. OFF.

For complete design and engineering specifications, write for catalog: Timing Motors No. 322 — Timers No. 323 — Clock Movements No. 324. Yours without obligation.

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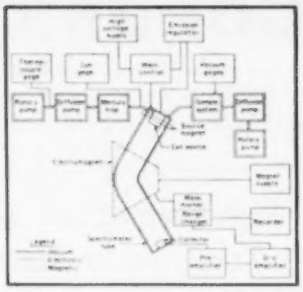


Principle of operation of the mass spectrometer is illustrated above

the instrument panel automatically rotates in synchronism with the sweep of the magnetic field to indicate each mass number. In conjunction with this, a mass marker identifies every fifth mass on the recorder chart by means of a second recorder pen to provide ready reference for subsequent analytical calculations.

The Brown ElectroniK high speed strip chart recorder incorporated in the spectrometer reproduces peak heights whose relative intensities vary from 1 to 3,000. A range of 1 to 3,000 is accomplished through the operation of an automatic range changing system. The recorder chart comprises an 11-inch wide strip of paper with uniform divisions from 0 to 100. All peaks can be read with an accuracy for each scale which is the same percentage of full-scale peak intensity.

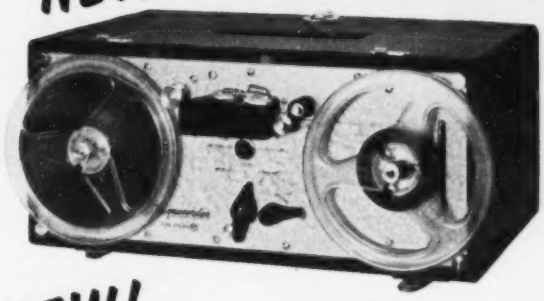
Industrial Uses

In nuclear energy laboratories, the instrument simplifies and expedites the solution of many problems in gas analysis. For example, where deuterium (heavy hydrogen) is a factor, the abundance of hydrocarbon materials in which a hydrogen atom has been replaced with a deuterium atom, can be quickly and accurately ascertained.

In the petroleum industry analysis by mass separation aids in setting up distillation columns for optimum operation, thereby effecting a reduction in costs and an improved efficiency. Analysis of process streams in thermal cracking units permits evaluation of potential outputs and processing efficiency. In catalytic cracking, the study of operating unit conditions feasible with the spectrometer aids

Now There's a Magnecorder for Every Tape Recording Need

NEW! PT63-A Offers 3 Heads

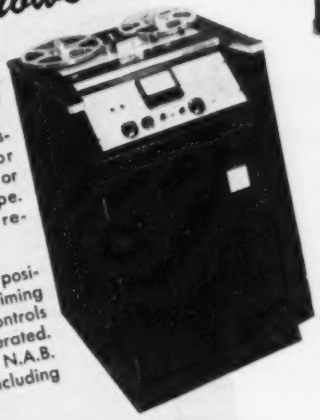


Monitor from the tape!

A new professional tape recorder with three separate heads: erase, record, playback for monitoring from the tape. This PT63-A Magnecorder incorporates all other fine features of the PT6-A. The new PT63-J Amplifier for single microphone recording includes separate playback amplifier.

NEW! the Talk of the Shows

Magnecorder PT7 Console



3 Heads In a single housing. Separate heads for erase, record, playback or monitoring from the tape. Separately alignable, replaceable.

New Features New positive drive eliminates timing errors. Push-button controls can be remotely operated. Accommodates 10½" N.A.B. reels on all models including portable.

Also Available As PORTABLE or RACK MOUNT
Same features included. Separate amplifier for each purpose. Portable amplifier has high-level mixing for three microphones.

NEW!

Three Heads and Amplifier Kit

Converts Your PT6-A To Monitor From Tape

Complete conversion kit includes new three-head unit, additional monitor amplifier and power supply. Three-head unit simply plugs into receptacle for present two heads on your PT6-A Magnecorder.

SPECIFICATIONS JUST RELEASED
Write for detailed information on these latest Magnecorder developments.

Magnecord, INC., CHICAGO 1, ILL.
360 NORTH MICHIGAN AVENUE
World's Largest and Oldest Manufacturers of Professional Magnetic Recorders

- **HIGH PERFORMANCE**—power gains up to 30,000.
- **LESS MAINTENANCE**—no filaments to burn out.
- **RUGGED CONSTRUCTION**—*no moving parts.*
- **NO WARMUP TIME**
- **RESPONDS TO SUM OR DIFFERENCE OF SEVERAL SIGNALS**
- **ALLOWS ELECTRICAL ISOLATION BETWEEN CIRCUITS**
- **STANDARD DESIGN**

In one recent application a Vickers Standard Magnetic Amplifier was used to maintain the frequency of the output of a 60-cps, 1 KVA generator within ±1%. This accuracy was maintained when the load varied from 0% to 100% and when the voltage on the d-c drive motor was varied ±10%. The output of a Type AD1-60-160-56 Standard Magnetic Amplifier was rectified and used to control the signal of the d-c drive motor. The error signal to the magnetic amplifier was supplied from two tuned circuits.

OTHER TYPICAL APPLICATIONS:

Speed regulators • Voltage regulators • Servo systems—positioners and indicators • Hydraulic controls • Control relays Temperature regulators • Lamp and furnace controls.

WRITE for your registered copy of the Vickers Magnetic Amplifier Design Handbook. Please make request on your letterhead.

VICKERS ELECTRIC DIVISION
VICKERS Inc.
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in revising and adjusting the cracker to obtain top production with the desired ratio of paraffins, olefins, and other hydrocarbon products. The apparatus also facilitates the analysis of light hydrocarbon streams such as overheads and bottoms of depropanizers and debutanizers.

With the mass spectrometer, chemical analysis of small quantities can be performed without the special techniques and painstaking work required by the usual methods. Minute liquid and certain solid samples can be readily vaporized so as to produce sufficient gas molecules for a complete automatic analysis. In addition, considerable time is saved in the identification of isotopes and impurities by this method of analysis.

In isotope research, the relative intensity of the isotope is immediately apparent and traces of rare isotopes are immediately indicated. Safe, non-radioactive isotopes can be concentrated and used as tracers in biological and chemical studies, using the mass spectrometer to interpret results.

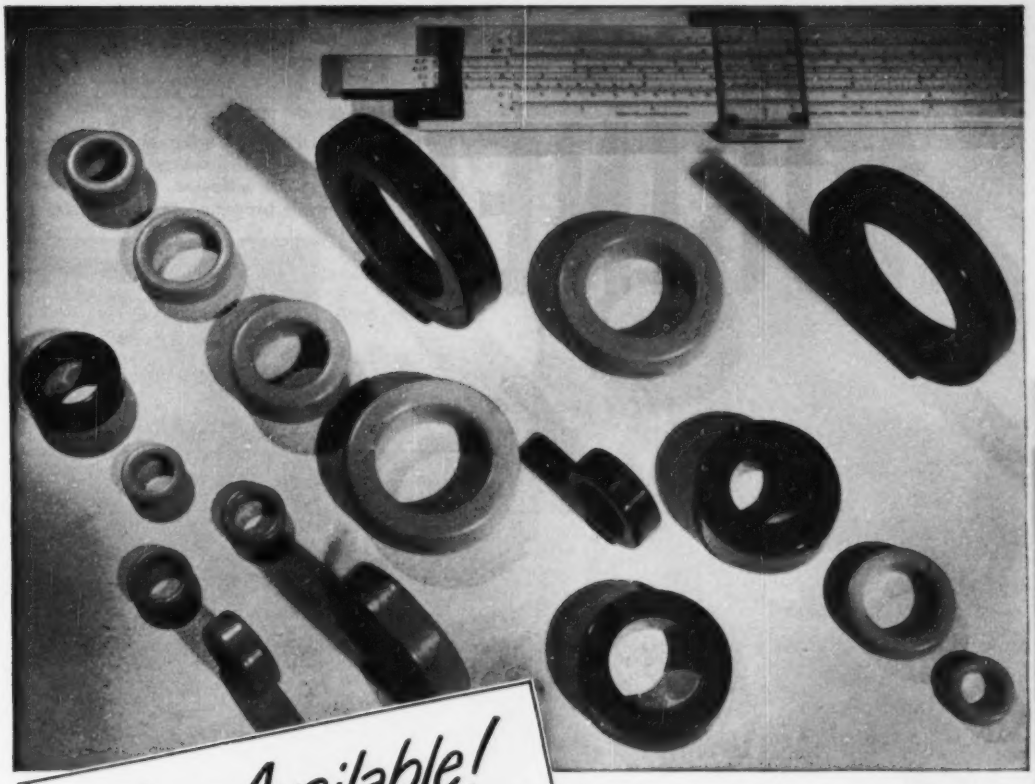
Mass spectrometry is also an effective tool in studies of molecular structures for the purpose of revealing the nature of the chemical and electrical bonds which hold together various complex molecules.

SHOP SHORTCUTS

ENDS of fairly heavy wires used in cable were difficult to secure in position while cord was applied. Spiral springs mounted above and below working area now hold wire ends between turns while cable is formed yet permit rapid placement and removal.

Westinghouse Electric Corp.
Baltimore, Maryland

INSPECTION and testing incoming components requires considerable time for setting up the test jigs and equipment. This time is saved by establishing semi-permanent test locations with all necessary instruments adjusted for specific components. Operators move from position to position as the load of incoming material shifts. Fortu-



Now Available!

MOLYBDENUM PERMALLOY POWDER CORES*

HIGH Q TOROIDS for use in Loading Coils, Filters, Broadband Carrier Systems and Networks—for frequencies up to 200 KC

COMPLETE LINE OF CORES TO MEET YOUR NEEDS

- ★ Furnished in four standard permeabilities—125, 60, 26 and 14.
- ★ Available in a wide range of sizes to obtain nominal inductances as high as 281 mh/1000 turns.
- ★ These toroidal cores are given various types of enamel and varnish finishes, some of which permit winding with heavy Formex insulated wire without supplementary insulation over the core.

For high Q in a small volume, characterized by low eddy current and hysteresis losses, ARNOLD Moly Permalloy Powder Toroidal Cores are commercially available to meet high standards of physical and electrical requirements. They provide constant permeability over a wide range of flux density. The 125 Mu cores are recommended for use up to 15 kc, 60 Mu at 10 to 50 kc, 26 Mu at 30 to 75 kc, and 14 Mu at 50 to 200 kc. Many of these cores may be furnished stabilized to provide constant permeability (±0.1%) over a specific temperature range.

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MIRROR is used by operator at chassis tie-down position to watch the crt mask on the front panel while properly locating chassis. To

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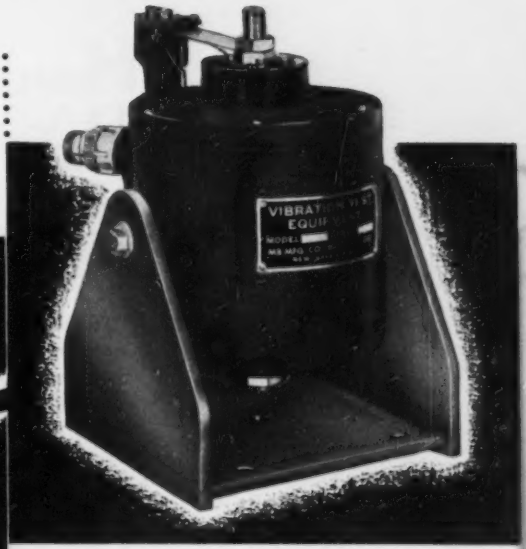
DETECT **and measure vibration with this MB PICKUP**



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Hermetically Sealed (Class A insulation)	105	21.3	100	2.0	100
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(continued from p 122)

variable pulse durations of 20 μsec to 1.5 sec.

Multivibrator

The circuit diagram is shown above. The variable-frequency generator is a simple stable multivibrator with three frequency ranges provided by ganged capacitor steps: 0.33 to 3.3 cps; 3.3 to 37 cps; 37 to 400 cps. A dual potentiometer provides fine adjustment.

A derivative of the multivibrator wave form is taken by a small time constant RC circuit (5×10^{-4} sec). The resulting spikes are amplified and reversed in polarity by a triode stage. The amplified spike is used to trip a univibrator of variable recovery time. The input side of the univibrator is normally non-conducting and a positive pulse is needed to trip it. The time for recovery after triggering is varied in three steps by capacitor selection: 20 μsec to 0.006 sec; 0.003 sec to 0.05 sec; 0.03 sec to 1.5 sec. The capacitor selected is charged through a variable resistance to give fine control. Minimum time for each range is determined by a fixed resistor switched in series with the variable control as the time range is chosen.

Univibrator

The multivibrator used has a small as well as large abrupt change in its output wave. After the derivative has been taken, amplified, and applied to the univibrator, there remains in addition to the main trigger spike a small spike slightly more than ½ cycle later which resets the univibrator if it has not recovered by itself before this time.

Biased Triode

The output wave of the univibrator is rectangular at the top, but undershoots on recovery. This signal is therefore directly coupled to another triode stage which is biased below cutoff when the univibrator is quiescent. It conducts on the positive swing from the univibrator, producing a rectangular voltage wave of negative polarity at the plate. The high-potential end of the resistor is grounded and the signal is taken between ground and the tap on a potentiometer in

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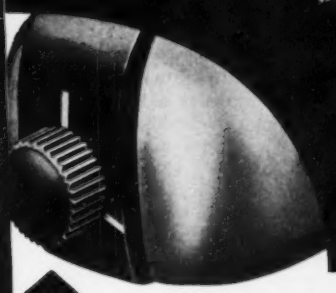

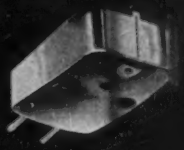

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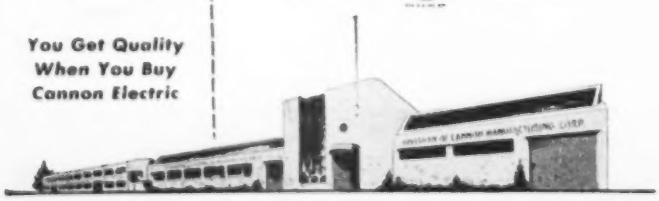

the plate lead. The potentiometer may be switched next to, or away from, the plate to give two steps of signal voltage differing by a factor of two.

Other steps of signal amplitude are obtained by switching the cathode resistors. For the values given, a change of about 15 in the signal is obtained. The small capacitor connecting the triode plate to its negative supply was added to remove a small spike overshoot on the leading edge of the rectangular wave at some gain settings.

Power Amplifier

The d-c power amplifier input is at ground potential, which is approximately 180 volts above its negative supply. The small resistance between the 6SL7 cathodes is provided to balance the output to zero in the no-pulse condition. A choice of current or voltage feedback is provided, allowing the selection of a rectangular current or voltage wave to the load.

Classical nerve and muscle rectangular wave excitation are usually accomplished by using a high voltage and a high resistance in series with the electrodes so that constant current is obtained through the tissue regardless of its impedance changes. Setting this amplifier to the current feedback position provides the same condition.

Two power supplies were conveniently available from a single transformer. The large coupling capacitor between them improved the stability on the lowest frequencies.

The work herein described was supported by the Baruch Center of Physical Medicine of the Medical College of Virginia.

Microseismic Arclight Timer

By Joseph A. Volk
St. Louis University
St. Louis, Missouri

Micro-oscillations in the ground and in the air are and have been for several years the subject of extensive research work. One microseismic research project at the Institute of Technology of Saint Louis University, under contracts with ONR, utilizes, to a certain extent, experience gained in recording quarry blasts of the Missouri

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Type X-1126, shown above, is rated at 115 volts, 50/60 cycles, 1 phase input with 0-135 volts, 12 amperes output. It is Underwriters' Approved for Class 1, Group D service.

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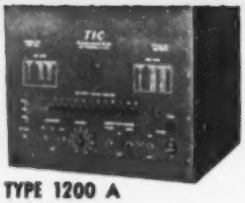

TYPE 1200 A
12 CHANNEL
R.F. SWEEP GENERATOR

Intended for precise adjustment of R.F. head oscillator coils and R.F. band pass circuits. Pulse type markers at picture and sound carrier frequencies extend to zero signal reference base line. Accuracy of markers 0.02% of carrier frequency. 12 to 15 MC. sweep on all channels. Max. 1.V peak output across a 75 ohm line. Provisions for balanced input receivers. Instant selection by push button.

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MULTI-FREQUENCY GENERATOR

A 10 frequency, 400 cps. modulated crystal controlled oscillator, ideal for production line adjustment of stagger tuned I.F. amplifiers. Available with crystals ranging from 4.5 to 40 M.C. Output frequency accurate to 0.02%. Immediate push button selection of frequency. Output attenuator range .5V to 500 microvolts. Self contained regulated power supply.

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A two band sweeping generator covering the range of 4.5 to 50 M.C. Capable of a band width of approximately ±25% on either band. Five pulse type crystal generated markers to specified frequencies available for each band. Accuracy of markers .05%. Zero signal reference base line, with markers extending to base line. I.V. output max. into 75 ohms. A saw sweep available for "X" axis of scope.

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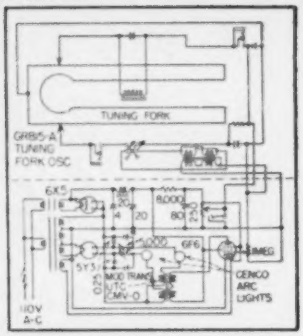


FIG. 1—Schematic diagram of arc-light timer for use in microseismic research

Portland Cement Company in the northwestern part of St. Louis county.

Since the periods of both the quarry blast waves and the microseisms are short, the basic requirements for establishing a convenient time base are essentially the same. Timing markers of 1/50 to 1/100 second have been found most convenient and are most widely used today in the field of seismic research.

The most common recording system shows the seismometer response together with superimposed timing lines. These lines are reflected from a simple mirror galvanometer which is excited by a 50-cps tuning-fork oscillator. While this method of timing is basically simple, it has many disadvantages which eventually led to the elimination of the mirror galvanometer through the use of an arc-light tube in conjunction with the usual tuning-fork oscillator. The light is pulsed to give accurately spaced flashes which are reflected onto the photographic recording strip along with the seismometer response.

The timer circuit is shown in Fig. 1. Two Cenco arc lights are used. Each of these may be used

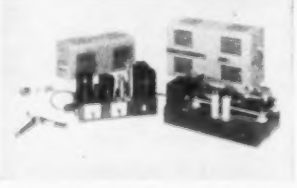
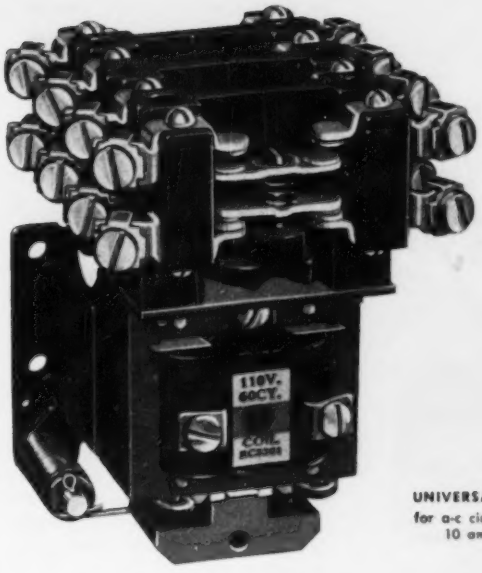


FIG. 2—Microseismic timer showing two Cenco arc lights, the modulator chassis and the GR tuning-fork oscillator



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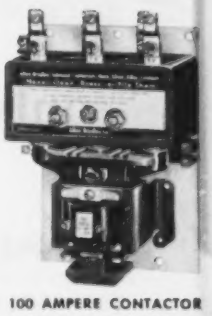

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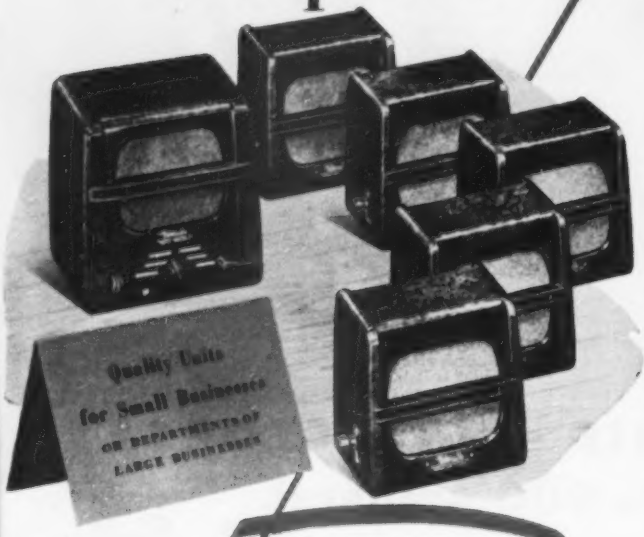

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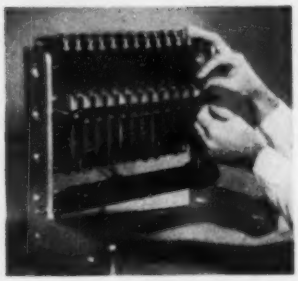

FIG. 3—An 8-watt fluorescent lamp is used to generate 12 synchronized timing pulses in the setup shown

with up to six typical recording channels. The small but intensive light spot, only 0.004-inch diameter, is ideal for pin-point recording spots. The main disadvantages of these types of lights is their rather high starting voltage and the wandering spot.

The starting relay in the power supply usually used with the Cenco arc light has been dispensed with by the use of a high-impedance power supply delivering a no-load voltage of approximately 1,250 volts d-c. As soon as the arc lights fire, the arc light current causes the arc light voltage to drop to about 35 volts which is automatically maintained over a wide range of line voltage variation.

The plate current of the 6F6 is controlled by the tuning-fork oscillator. Thus a time marker of 1/50 sec is inserted so that the arc light serves as both recording light and time-base marker. The tuning-fork used requires 4 volts at approximately 20 ma.

10-CPS Beatnote

By purposely introducing a 60-cps component through the d-c filter system, a 10-cps beatnote is obtained which is useful in counting the timing lines. This aid is most helpful when paper speed of the recording camera is slow, say 1/3 cm per sec or less.

Figure 2 shows the arclight timer with the covers of the main components removed. The useful life of the Cenco lights is approximately 400 hours, which is considered sufficient for any but continuous recording purposes. Intermittent use can as much as quadruple the life of these tubes. Where longer life is desired, the Sylvania 1130-B should be used,

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*Manufacts—manufacturing facts

BARKER & WILLIAMSON, INC.

237 Fairfield Avenue — Upper Darby, Pa.

its life being approximately 10,000 hours.

The Cenco arclight may be replaced by an 8-watt fluorescent light, provided a long enough optical path, together with individual condenser lens, is provided. In this case, it is most practical to mount the fluorescent light inside a metal tubing with a number of slots corresponding to the number of channels required. This type of mounting is shown in Fig. 3 for a 12-mirror-galvanometer recorder. The light passes through the slits to the mirror galvanometers and is reflected back to the recording slot.

Magnetic Tape Is Memory for Computer

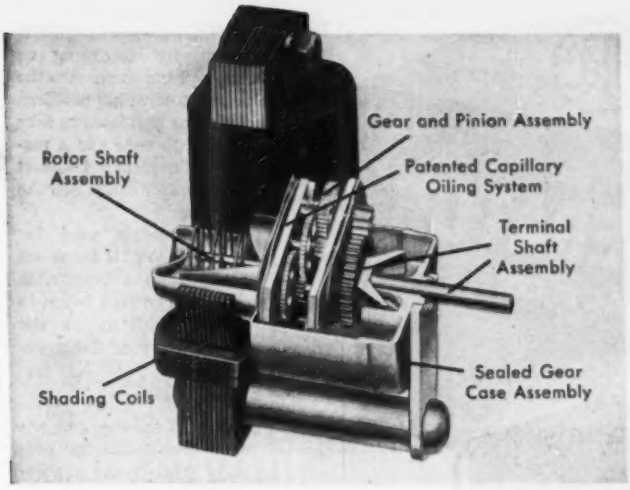
A MEMORY SYSTEM capable of storing 64,000 digits and leading a computing machine through a complex mathematical problem of 4,000 steps is a part of Harvard University's new Mark III calculating machine, to be used by the U. S. Navy Bureau of Ordnance.

The system consists of eight storage drums and a sequencing drum. Problems are solved by feeding information on a magnetic tape to the sequencing drum, which in turn commands the computing section to accomplish the desired operations with the numbers in the storage drum. The results come out of the machine on another magnetic tape.

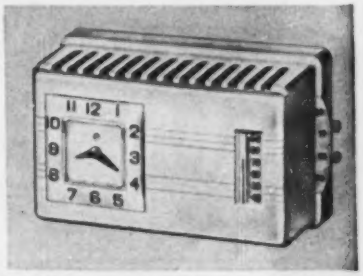
Both the information for carrying out given operations and the numbers with which the operations are performed are represented by small magnetic spots on the surface of the rapidly rotating drums. An elaborate system of recorders and play-backs circulates the information between the drums and other parts of the machine. The drums revolve at speeds up to 120 revolutions per second and the magnetic spots move by the recording and play-back heads at speeds greater than 150 miles per hour.

Coding Keyboard

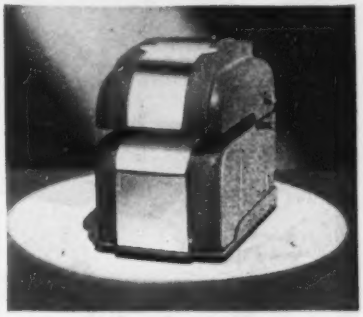
A coding box speeds up the process of translating mathematical symbols and operations into a language the machine can use. Over 200 keys each have a number or mathematical symbol. The operator in effect copies his equations on



Telechron Type B Synchronous Motor. For switches, recording-controlling mechanisms and other medium duty controlling purposes. Other models available with lower or higher torques for light or heavy duty applications.



Controlling the timing of heat regulators is typical of the jobs well done by Telechron Type H3 light duty motors.



Most time-stamps and recorders owe their accurate timing to Telechron Type B motors because such applications demand a motor that is instantly, constantly synchronous.

Unique Oiling System Prolongs Timing Accuracy

Capillary action in the spaces between each bearing and capillary plate of Telechron Timing Motors draws a specially formulated oil from the reservoir at the bottom of the sealed gear case. This keeps bearings and pivot surfaces constantly covered with a thin coating of oil. Oil creepage along the shafts, pinions and gears maintains complete, continuous lubrication. Brass terminal gear baffles meter the right amount of oil to the terminal shaft bearing . . . cutting down bearing wear and making the sealed-in oil supply last for years.

This oiling system is just one of many reasons why *all Telechron Timing Motors are instantly, constantly synchronous* . . . and why designers concerned with split-second timing or precise control of lightweight moving parts invariably specify Telechron motors.

If accurate timing enters into your product design, talk things over with a Telechron Application Engineer. Backed up by the experience that makes all electric timing possible (virtually all frequency-controlling master clocks in power stations are made by Telechron), he can probably show you how to save time and money by fitting a standard Telechron motor into your product. In the meanwhile, get complete data by mailing the coupon below. Telechron Inc. A General Electric Affiliate.

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Built to Navy Specifications for research and production testing

Write for specifications — investigate the advantages of this outstanding new instrument.

DEPENDABLE ELECTRONIC EQUIPMENT SINCE 1928

Aircraft Radio Corporation
BOONTON, New Jersey

this keyboard, for recording on magnetic tape all the commands the machine needs to solve his problem. Complex problems that used to take days and weeks to code for a machine can now be prepared almost as fast as an operator can punch the keys on the box.

A magnetic tape is used for answers because Mark III turns out answers faster than a typewriter can print them. The tape is fed to a tape reader which relays the answers to a battery of five typewriters.

Error Detectors

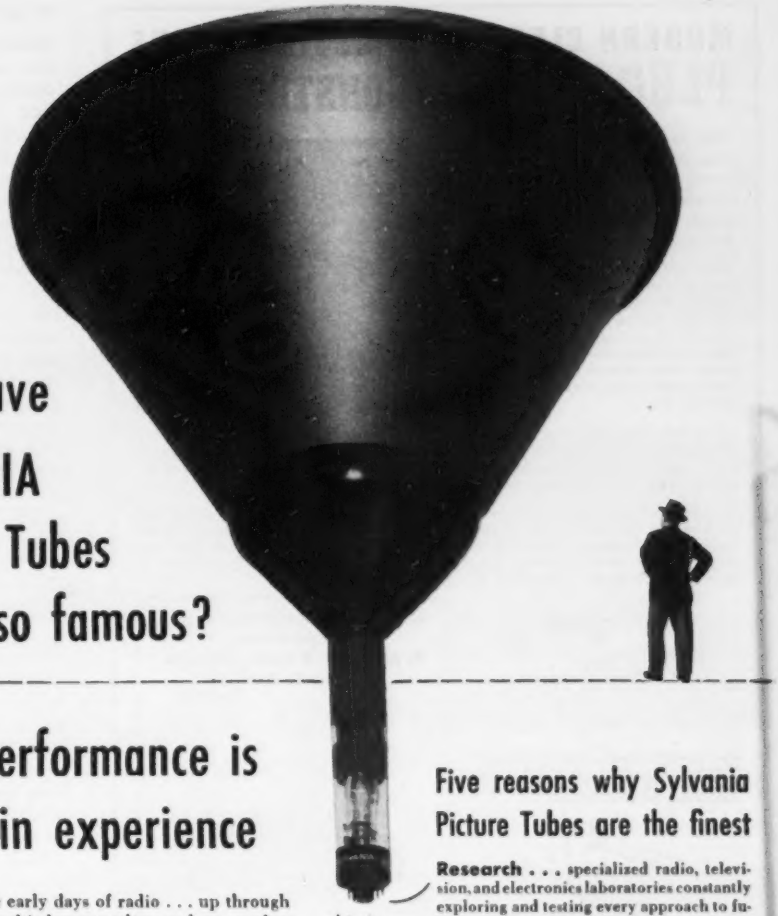
Computations of the machine are checked at several points for possible errors. During the mathematical operations in the arithmetic section of Mark III, answers are double-checked at every stage in the problem before going on to the next stage. To insure that the final typed results are correct, all numbers are recorded twice on the magnetic tape by two parallel and independent systems. Unless both numbers on the tape are identical, the striking action of the type bars sets off an alarm and stops the typewriters.

To eliminate errors that might creep into answer sheets during type-setting and printing of permanent records, the results are printed directly to pages which can be photographed and printed by offset lithography for publication in quantity.

Mark III, which was begun in May, 1946, has been built for the Bureau of the Ordnance of the U. S. Navy to be used at the Naval Proving Ground Command at Dahlgren, Virginia. It is anticipated that testing operations will have been completed by the first of the year and the machine will go to the Navy at that time. The complete instrument is about 30 feet long and 15 feet wide and weighs close to 10 tons. It contains about 4,500 vacuum tubes for the electronic operations, 3,000 relays and 2,500 magnetic heads and playbacks to carry the information to and from the storage drums.

Project Personnel

Dr. Benjamin L. Moore, Assistant Director of the Computation Laboratory and Dr. Way Dong Woo, Assistant Professor of Applied



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During the war period, Sylvania's production of precision radar equipment and cathode-ray tubes added much to the skills and know-how of Sylvania engineers.

Still further contributions to Sylvania's high standing in the picture tube field have come from this company's half-century experience in lighting . . . and in perfecting new phosphors for the finest in fluorescent lamps.

Born *AND* Made—It's important to remember that Sylvania is a picture tube *manufacturer* . . . not merely an assembler!

Every Sylvania part is quality controlled by Sylvania craftsmen. Even the micro-fine tungsten filaments are drawn and tested in Sylvania plants. That's why we say Sylvania picture tubes are born *and* made to serve better . . . last longer. For full information, write: Sylvania Electric Products Inc., Dept. R-2105, 1740 Broadway, New York 19, N. Y.

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Research . . . specialized radio, television, and electronics laboratories constantly exploring and testing every approach to future improvement.

Background and Experience . . . 25 years a recognized leader in highest quality radio and electronic tubes. Developed new fluorescent lighting phosphors and techniques applicable to TV picture tube production.

Engineering Development . . . alert engineering procedures assure efficiency and speed production of all Sylvania products.

Quality Control . . . a continuing program of checking and rechecking every step of every process to assure, beyond question, the perfect performance of Sylvania Picture Tubes.

Enlarged Plant Facilities . . . 2 great plants, devoted exclusively to TV picture tube production, assure quick delivery to your factory anywhere.

SYLVANIA ELECTRIC

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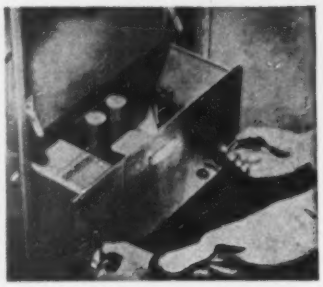
MODERN ELECTRONIC DESIGN MEANS PLUG-IN UNIT CONSTRUCTION

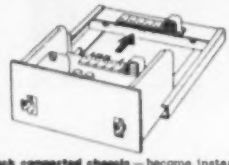
With basic elements as units—that plug-in, slide-in, lock-in, break away easily—so that electronic equipment is instantly accessible—ready for rapid checks, servicing, and unit replacement.



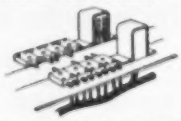
More and more engineers are finding that *plug-in unit construction* is the type of design that makes many of the new complex electronic projects feasible to operate and maintain. It's also recognized that *plug-in, unit principles* make present electronic equipment much more practical for wider general use.

Up to now there has been no one place where components *specifically designed for plug-in, unit construction* were available. To get this type of construction—it has been necessary for engineers to design and have parts custom made or improvise with standard components in make shift arrangements.

Here at Alden's we are designing and manufacturing components for *plug-in unit construction*. We are setting up to work with manufacturers on as many of these problems as possible. Very frankly, much of our work is still in the pilot run stage—but, in every instance—proven in use. If you don't see the answer to your problems here—let us work it out with you.



Rack connected chassis—become instantly accessible. Half twist of handles brings chassis into place or ejects—no matter how heavy. Built for racks or as separate units—miniature and standard sizes.



Rugged color coded back connectors—make and break circuits—provide rapid circuit checks. Wide mating tolerances compensate for any chassis misalignment. Miniature and heavy duty sizes.

Top operated clamps for tubes and plug-in units. Take minimum of space. Can be operated in cramped locations. Free floating—orients unit to socket without straining or bending pins.

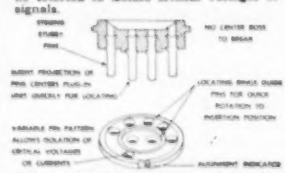
Alden Cap Captive Convenience Screws—Hold miniature chassis, heavy plug-in cans or detachable mechanical units securely. Assemble easily in production by power tools—yet any tool or coin services in field.

At last—a base specifically designed for plug-in units. No more broken bosses, bent pins, "shorted" circuits.

More and more engineers have been unitizing the basic elements of their circuits into compact, easily replaceable plug-in units. Since the conventional octal and tube socket bases have been the only component readily available, they have been constantly plagued by the broken bosses, bent pins, and "shorted" circuits caused by these bases.

This suggested an entirely new approach was necessary, so we went to work with some of these engineers. Out of this work the *Alden-Noninterchangeable plug-in base* was developed.

Pins have been made strong and stubby—for long, rugged use. The boss is eliminated entirely. Slight lead of center pins and locating rings with marker in the socket allow quick lining up of plug-in units. Further, this base is supplied with 2 to 11 contacts—in variable pin patterns—so that even where the same number of contacts are used, the pin layout may be varied so only the correct unit will mount in its proper socket. Pin patterns can even be selected to isolate critical voltages or signals.



Write today for literature and samples. Let Alden work with you on your components for *plug-in, unit construction*.

Write for new booklet on "Components for Plug-in Unit Construction"

ALDEN PRODUCTS CO. 117 NORTH MAIN ST. BROCKTON 64, MASS.

Mathematics at Harvard University, were directly in charge of its development, design and construction. Mechanical design and construction of the internal high-speed magnetic drum storage system, one of the major components of Mark III, was the work of Robert Wilkins, assisted by Dexter Smith. The adder and multiplier were largely the work of Charles Coolidge. Marshall Kinkaid was mainly responsible for the over-all design of the sequencing circuits. The input and output circuits were constructed by Richard Hofheimer. Charles Richards, who had previously worked on Mark II and will go to Dahlgren with Mark III, also worked on design problems throughout the construction period.

Dr. Howard Aiken, co-inventor of the original calculating machine and director of the Harvard Computation Laboratory, had general supervision of the project.

Antilogarithm Circuit

CIRCUITS of the type shown in Fig. 1 have long been used, with variable-μ type tubes, for extracting logarithms directly. For instance, using a 6SK7, the plate current follows the grid voltage logarithmically over a range of grid voltages from -10 to -20 volts when a cathode resistance of 10,000 ohms is used. The type 6SG7 displays similar characteristics when its grid is operated between -4 and -10 volts.

In an article in February, 1950, *Review of Scientific Instruments*, F. Curtis Snowden and Harold T. Page reveal that if this type of circuit is operated in reverse, as shown in Fig. 2, antilogarithms can be extracted directly, as might be expected. A 6SK7 is connected as an inverted triode; the signal is applied to the plate, which acts as

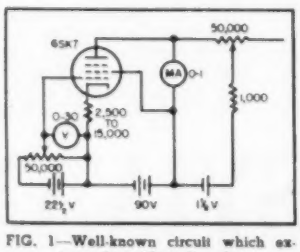
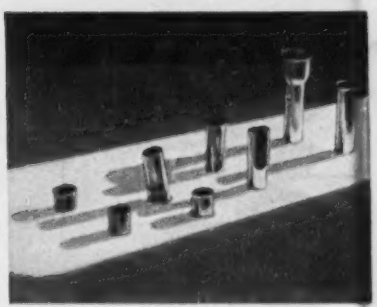


FIG. 1—Well-known circuit which extracts logarithms directly

Through this portal pass the nation's top stars

All in a Day's Work—Chemical Laboratory continually samples raw materials; checks and controls quality from suppliers.



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● You may not recognize the object pictured above. It is the first grid cylinder for a cathode ray tube gun structure, photographed from an unusual angle. The hole is only .040" in diameter—and the grid itself is deep drawn in one piece to save unnecessary welding and assembly operations by TV tube manufacturers.

This is tubing technology in operation. It is an example of Superior's superiority in electronic research, production know-how and facilities, and metallurgy. It is one product of hundreds pioneered for the electronic industry by Superior.

You may already be one of our valued customers and friends—nearly all electronic manufacturers are. If small Seamless or †WELDRAWN tubing can help anywhere in your product Superior can help you. To find out how, write Superior Tube Company, 2500 Germantown Avenue, Norristown, Pennsylvania.

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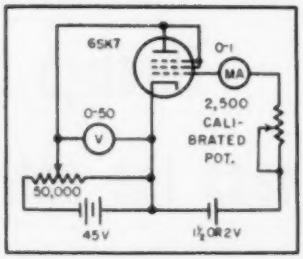

FIG. 2—Inverted-triode circuit for direct determination of antilogarithms

a grid, and the output is drawn from the grid element, which acts as a plate.

The range of input (plate) voltages over which the output (grid) signal will maintain its antilogarithmic relationship with that of the input (plate) is dependent on several factors, most important of which is the tube type and the characteristics of the particular tubes of a certain type. The desired relationship held for a grid voltage range of from — 18 to — 30 volts with a load resistance of 1,000 ohms. When glass tubes are used the lower limit of the range is extended to about — 15 volts.

The output from the circuit must be amplified in order to be put to any useful work.

Measuring pH of Biological Fluids

By Allan Hemingway and E. B. Brown

Department of Physiology
Medical School
University of Minnesota
Minneapolis, Minn.

In the measurement of the pH of blood with the glass electrode it is necessary to measure a d-c voltage of the order of magnitude of a fraction of a millivolt in a circuit having a resistance of 10 to 200 megohms. At the same time exact temperature control of the glass electrode must be maintained which necessitates a water bath which in turn introduces errors due to insulation leakage. Many of the difficulties in the measurement of blood pH have been eliminated by the circuit devised by Burr, Nims and Lane.[1, 2]

There are, however, some annoy-

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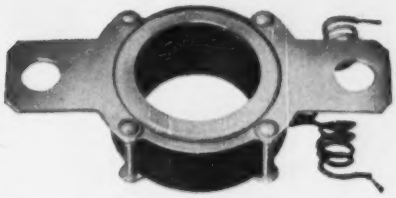
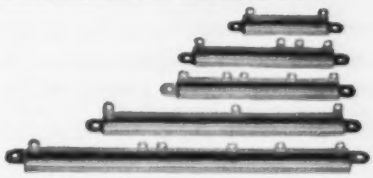


Available in two types: The first utilizes an electro-magnet; the second combines a permanent magnet with an adjustable electro-magnet. I-T-E Focus Coils are made for use with tubes 10", 12", and 16" in size. Information required to manufacture: Type of tube; second anode voltage; focusing current; types of mountings and leads desired.

I-T-E DEFLECTION YOKES

I-T-E Deflection Yokes are built to have uniform characteristics. During manufacture, wire size and quality are checked constantly. Coils are impregnated with a special moisture-resistant thermo-plastic material which has been properly cured to insure a firm coil with a minimum of losses. Deflection Yokes can be had with wire leads, resistors, and capacitators made to your specifications.

I-T-E "METCLADS" (Metal-Clad Resistors)



Made of highest-grade resistance wire, wound on a special heat-resistant bakelite strip, and insulated by special phenolic coating. The resistance element is completely enclosed in a metal case of either brass- or zinc-plated steel. Brass terminals are securely anchored to the bakelite base strip and are tinned for easy soldering. I-T-E "Metclads" are available in lengths from 2" to 12"; in wattages from 7 to 42. Mountings can be made to your specifications.

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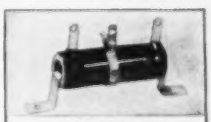
STANDARD FIXED RESISTORS from 5 to 200 Watts



ADJUSTABLE RESISTORS from 10 to 200 Watts

OVAL RESISTORS for limited space requirements —from 50 to 75 Watts

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ing and irritating difficulties which make operation of their instrument a task requiring considerable skill and experience. The worst feature of this circuit was the almost continual drift caused by the changing voltage of the storage battery which this circuit requires.

A pH meter has been built using Raytheon CK 570 AX tubes in the Wynn-Williams type of circuit which was used by Burr, Nims and Lane for pH measurement. The instrument so constructed has now been in operation for a year and has given excellent service when used to measure pH of blood whose temperature is controlled in a water bath. The advantages of the new type of pH meter over the older type include exceptional stability and freedom from drift, a simpler arrangement for initial bridge balancing, operation from readily available dry cells, and a rapid warmup period.

Schematic Circuit

The schematic circuit of the pH meter is shown in Fig. 1. The two electrometer triodes have a filament power supply from a single 1.5-volt number 6 dry cell. A 10-ohm variable potentiometer between the positive terminals of the filaments allows an adjustment to be made of the relative filament currents in the event that the characteristics of the two tubes are not identical. In well-matched tubes this variable resistance may not be necessary. When the two tubes are electrically matched by varying this resistance slight variations in filament battery voltage do not change the balance of the bridge circuit.

The two tubes have a common grid voltage obtained from the grid potentiometer. Originally the grid of right-hand tube was connected directly to filament. With this

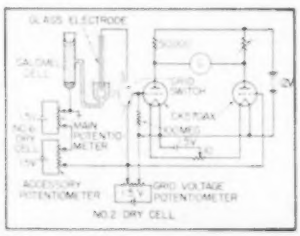

FIG. 1—Simplified schematic of stable biological pH meter

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Horizontal sync-pulse as displayed on WO-57A screen

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The RCA WO-57A

High Gain — Wide Band — DC and AC Input.

The WO-57A is an outstanding innovation in portable oscilloscope design. Especially suited for television, this new scope is excellent for laboratory, factory, or shop use . . . for viewing and measuring square waves, pulses, TV sync signals, and sine waves.

Unusually versatile . . . newly designed from stem to stern . . . the RCA WO-57A Oscilloscope is a triumph of engineering.

Incorporating the features of far more expensive instruments . . . and with a sensitivity and response equal to that of many laboratory units . . . the WO-57A is the first inexpensive oscilloscope wholly equipped to handle every TV and radio service job.

Direct-coupled amplifiers are used to provide low frequency response flat down to dc. Excellent low-frequency square-wave reproduction, essential for correct sweep alignment, is thus assured. High-frequency square-wave response up to 100 kc enables the WO-57A to reproduce blanking and sync pulse wave shapes with fidelity heretofore unobtainable in moderately priced service-type oscilloscopes.

For complete technical details, ask your RCA Test Equipment Distributor for the bulletin on the new WO-57A, or write RCA, Commercial Engineering, Section E42Y, Harrison, New Jersey.

Check these important features!

- ✓ **Sensitivity**—25 millivolts per inch deflection.
- ✓ **Frequency Response** of vertical amplifier—flat within 3 db from zero to 500 kc; down only 55% at 1 Mc; useful beyond 2 Mc.
- ✓ **Transient Response**—tilt and overshoot less than 2%.
- ✓ **Utility**—provided with frequency-compensated and calibrated step attenuator. Also has vernier control and calibrated voltage source.
- ✓ **60-Cycle Sweep**—with phasing control.
- ✓ **Input Capacitance**—less than 15 uuf with WG-214 accessory probe.

Plus these outstanding extras

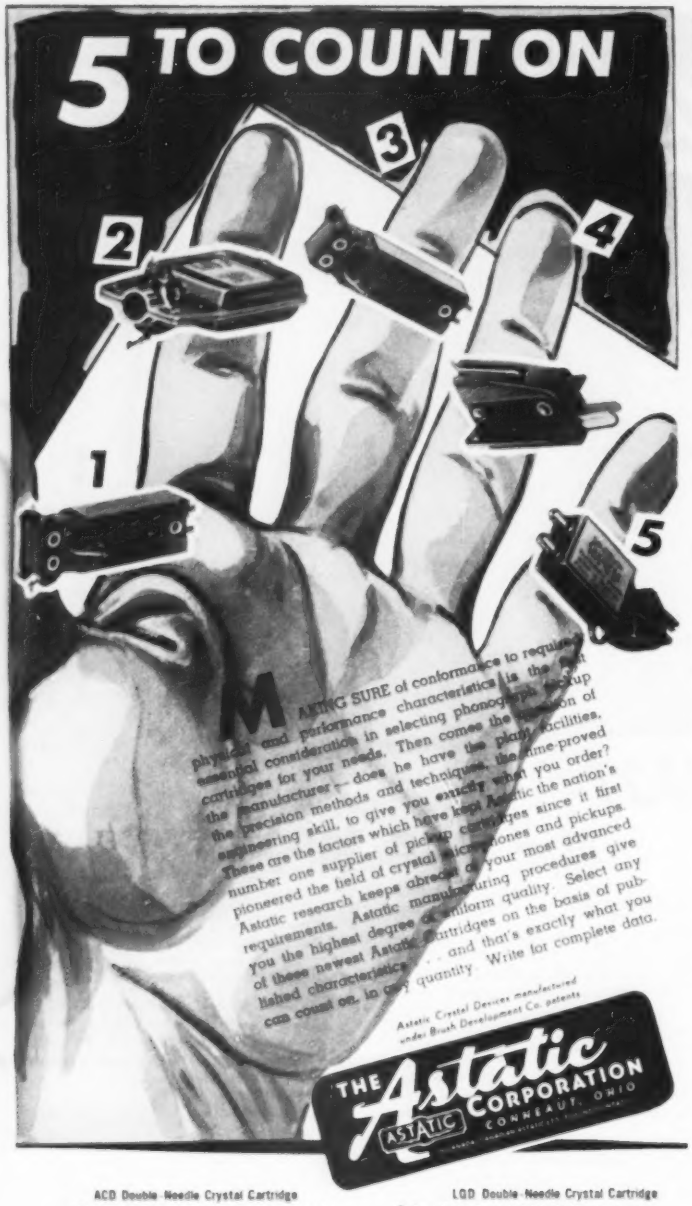
- \+ **Trace Expansion**—two times screen diameter for sweep-alignment applications.
- \+ **Direct Coupled Vertical Amplifier**—separate jacks for DC and AC signal measurements.
- \+ **Linear Sweep**—range 15 to 50,000 cps, with preset fixed positions for viewing vertical and horizontal TV sync pulses and oscillator waveforms.
- \+ **Exclusive**—sweep direction reversing switch—positive or negative syncing.
- \+ **Push-Pull Amplifiers**—produce sharper trace and reduces astigmatism.
- \+ **Standardized case** fits test racks WS-17A and WS-18A.

Power supply . . . 105/125 volts, 50/60 cycles.

Probe Kit (WG-214)—$7.50. Includes input cable with direct probe, slip on low-capacitance probe, and ground lead for observation of sync pulses, oscillator wave-forms and video signals without undue circuit loading.

Available from your RCA Test Equipment Distributor

RADIO CORPORATION of AMERICA
TEST EQUIPMENT — HARRISON, N. J.


5 TO COUNT ON
1
2
3
4
5
MAKING SURE of conformance to required physical and performance characteristics is the first essential consideration in selecting phonograph pickup cartridges for your needs. Then comes the question of the manufacturer — does he have the plant facilities, the precision methods and techniques, the time-proved engineering skill, to give you exactly what you order? These are the factors which have kept Astatic the nation's number one supplier of pickup cartridges since it first pioneered the field of crystal microphones and pickups. Astatic research keeps abreast of your most advanced requirements. Astatic manufacturing procedures give you the highest degree of uniform quality. Select any of these newest Astatic cartridges on the basis of published characteristics . . . and that's exactly what you can count on, in any quantity. Write for complete data.
Astatic Crystal Devices manufactured under Brush Development Co. patents
THE Astatic CORPORATION
ASTATIC CONNEAUT, OHIO
ACD Double-Needle Crystal Cartridge
1 Newest Astatic miniature turnover model featuring mechanical drive system with new low inertia. Result — sensationally smooth response, new tracking excellence, low needle talk. Output 1.0 volt at 1,000 c.p.s. Needle pressure six grams.
AC Crystal Cartridge
3 Tiny, single-needle version of the new ACD with same unparalleled smooth response. AC-J for slow speed records has five gram needle pressure. AC-AG-J with special All-Groove needle tip for all record types has six gram needle pressure. AC-78-J for 78 RPM records has six gram needle pressure. Output of each is 1.0 volt at 1,000 c.p.s.
LQD Double-Needle Crystal Cartridge
2 The PROVED TOP PERFORMER for turnover type pickups today. Outstanding for excellence of frequency response, particularly at low frequencies. Output 1.2 volts on slow speed side; needle pressure six grams. 0.5 volt on 78 RPM side, eight grams. Available with or without needle guards.
GC Ceramic Cartridge
4 The first ceramic cartridge with replaceable needle. Takes the Type G needle — with either one, three-mil or special All-Groove tip, precious metal or sapphire — which slips from its rubber chuck with a quarter turn sideways. Output has been increased over that of any other ceramic cartridge available. Light weight and low minimum needle pressure.
CQ Crystal Cartridge
5 Features miniature size and five-gram weight. Models CQ-J and CQ-AG-J fit standard 1/2" mounting and RCA 45 RPM record changers. Model CQ-1J fits RMA No. 2 Specifications for top mounting 453" mounting centers. Output 0.7 volt at 1,000 c.p.s. Employ one-mil tip (radius "J" Needle, or special All-Groove tip (Model CQ-AG-J).

newer arrangement adjustment of the grid voltage to obtain the floating grid potential does not cause the excessive unbalance of the bridge which occurred in the older circuit. This adjustment for floating grid potential is made each time the instrument is used and usually one setting a day will suffice.

To adjust for floating grid potentials the grid switch is thrown from position 1 to position 2 while the grid voltage is varied. When there is no change in galvanometer current as the grid switch is thrown from position 1 to position 2 the grid potential is that of the floating grid and grid current is zero.

The main potentiometer as in most pH meters will read in pH units, that is, one revolution of the slide wire and one coil of the accompanying resistor decade will furnish a voltage varying from 57 to 63, the exact voltage being set for a particular temperature of the glass electrode. The pH meter functions in the usual manner with the vacuum-tube circuit functioning as a null instrument to indicate the balance between the voltage of the glass electrode and half cells, and the measuring voltage obtained from the main potentiometer.

The main potentiometer is best constructed from the slide wire and decade coils of a commercial potentiometer, a Leeds and Northrup student type being used in the instrument described. All variable potentiometers were General Radio, using type 314 where possible and type 214 for the lower values. The circuit diagram shown is, of course, extremely simplified for purposes of brevity of explanation of the basic principle involved.

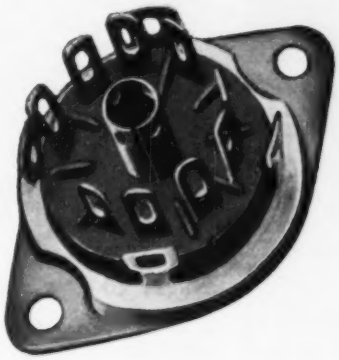
Performance

An important improvement in this meter in comparison with other, especially commercial, pH meters is the use of ordinary batteries which are readily available and the avoidance of special-purpose rectangular-type batteries. A common annoyance in biological laboratories is the replacement of special-purpose batteries which are not available except in electronic or laboratory supply stores and sometimes only available by mail order purchase. For this reason the

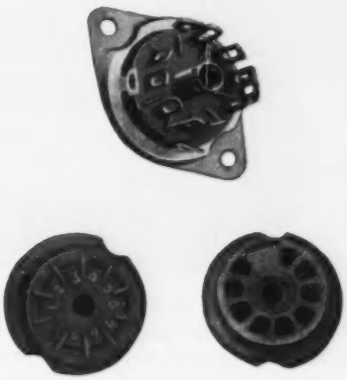
Announcing

NEW MEMBER OF THE MYCALEX FAMILY

9 Pin Miniature Tube Sockets



Enlargement of the new 9 (NOVAL) pin miniature tube socket.



Above: Complete 9 pin miniature socket.
Below: Precision moldings in MYCALEX actual size two views.

We are proud to announce the addition of a 9 pin (NOVAL) miniature tube socket to the MYCALEX line. It has all the electrical characteristics of the widely used MYCALEX 410 and 410 X 7 pin tube sockets and fully meets RMA standards.

The NOVAL is injection molded and produced in two qualities to satisfy different requirements.

MYCALEX 410 for applications requiring close dimensional tolerances. Insulation loss factor of .015 (at 1 MC) yet compares favorably in price with mica filled phenolics.

MYCALEX 410X for applications where general purpose bakelite was acceptable but with an insulation loss factor of only .083 (at 1 MC). Prices compare with lowest quality insulation materials.

Write us today and let us quote you prices on your particular requirements. We will send you samples and complete data sheets by return mail. Our engineers are at your disposal and would be glad to consult with you on your design problems.

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Phase measurements are made instantly and accurately—no balances, adjustments or corrections are involved. Phase angle readings at audio and ultrasonic frequencies are indicated directly on a large wide-scale meter with ranges of 360°, 180°, 90° and 36°. Useful frequency range 2 cps. to 100 k.c.

In audio facilities, ultrasonics, servomechanisms, geophysics, vibration, acoustics, aerial navigation, electric power transformation or signaling . . . in mechanical applications such as printing register, torque measurement, dynamic balancing, textile and packaging machinery and other uses where an accurate measure of the relative position of moving parts is required . . . the Phase Meter is a long needed measuring instrument never before available — a new tool for a heretofore neglected field of measurement.

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1058 Main Street, Waltham 54, Massachusetts
Engineering Representatives: Cleveland, Ohio—PRospect 1-6171
Chicago, Ill.—UPtown 8-1141 · Dallas, Tex.—LOgan 6-5092 · Rochester, N.Y.—Charlotte 4194 J
Cambridge, Mass.—ELiot 4-4751 · Canaan, Conn.—Canaan 640 · Hollywood, Cal.—HOllywood 9-6305

present pH meter has been constructed to use only commercial readily available batteries, namely the number 2 and number 6 dry cells.

A satisfactory galvanometer is the Rubicon type 3414, sensitivity 0.0045 microampere per mm, resistance 540 ohms. The circuit including batteries but not including galvanometer is shielded in a wooden box lined with tin plated iron. The glass electrode is in a water bath using a compressed air driven stirrer.

The sensitivity of the instrument as measured by the galvanometer scale is 5-mm galvanometer deflection per 0.01 pH. The galvanometer is stable and can be read to 0.1 mm. The instrument does not use line power and hence is free from power main difficulties and has the added advantage that it can be used as a field instrument.

REFERENCES

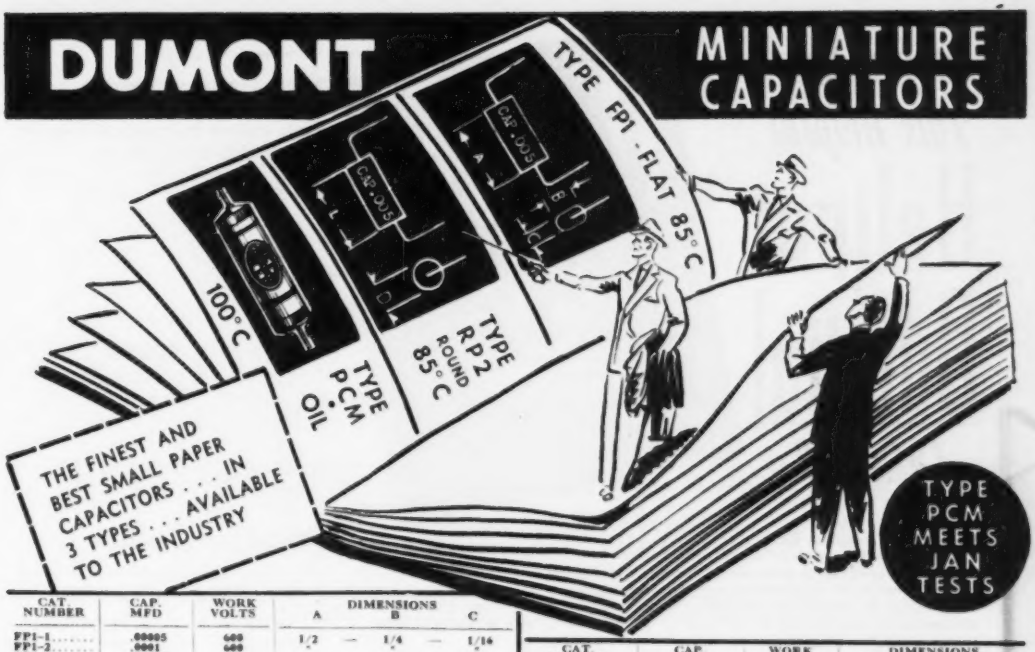
(1) H. S. Burr, L. F. Nims and C. T. Lane, *Yale J. Biol. Med.*, p 65, Sept. 1936.
(2) L. F. Nims, *Yale J. Biol. Med.*, p 26, Oct. 1938.

SURVEY OF NEW TECHNIQUES

A PROTECTIVE GRID near the thin aluminum window of a Geiger-Muller counter for beta rays prevents arcing to the window and consequent damage thereto. Potential gradient between the anode wire and the grid wire is made slightly greater than between anode and window, so that arcing due to overload will occur between anode and grid. The technique is described in detail in U. S. patent 2,452,524 issued to Herbert Metten of Sylvania Electric Products Inc.

USE of lycopodium powder to show nodal patterns of loudspeakers at various frequencies was described by Murlan S. Corrington at the recent Audio Fair in New York City, as a method of investigating transient distortions. The speaker is laid on the floor face up with the powder sprinkled on its cone. The voice coil is then energized at various frequencies. The resulting dust patterns are directly related to the manner in which the speaker handles the suddenly applied and suddenly removed sine wave.

DUMONT MINIATURE CAPACITORS


TYPE FPI - FLAT 85° C
TYPE RP2 ROUND 85° C
TYPE PCM OIL
100° C
THE FINEST AND BEST SMALL PAPER CAPACITORS . . . IN 3 TYPES . . . AVAILABLE TO THE INDUSTRY
TYPE PCM MEETS JAN TESTS

CAT. NUMBER	CAP. MFD	WORK VOLTS	DIMENSIONS A	B	C
FP1-1	.00005	600	1/2 —	1/4 —	1/16
FP1-2	.0001	600	"	"	"
FP1-3	.00025	600	"	"	"
FP1-4	.0005	600	"	"	"
FP1-5	.001	200	"	"	"
FP1-6	.001	600	1/2 —	3/8 —	1/16
FP1-7	.002	200	1/2 —	1/4 —	1/16
FP1-8	.002	600	1/2 —	1/4 —	1/8
FP1-9	.005	200	"	"	"
FP1-10	.005	600	5/8 —	3/8 —	1/8
FP1-11	.005	600	"	"	"
FP1-12	.01	200	1/2 —	3/8 —	1/8
FP1-13	.01	400	5/8 —	3/8 —	1/8
FP1-14	.01	600	"	"	"
FP1-15	.02	200	"	"	"
FP1-16	.02	600	5/8 —	3/8 —	3/16
FP1-17	.03	600	"	"	"
FP1-18	.03	200	5/8 —	5/8 —	1/8
FP1-19	.03	600	3/4 —	3/8 —	1/4
FP1-20	.03	600	"	"	"
FP1-21	.05	200	5/8 —	3/8 —	3/16
FP1-22	.05	200	3/4 —	3/8 —	1/8
FP1-23	.05	600	3/4 —	1/2 —	3/16
FP1-24	.05	600	"	"	"
FP1-25	.1	200	3/4 —	3/8 —	1/8
FP1-26	.1	400	3/4 —	5/8 —	1/4
FP1-27	.1	600	3/4 —	5/8 —	3/8
FP1-28	.25	100	"	"	"
FP1-29	.25	200	1 —	5/8 —	5/16
FP1-30	.25	400	1 1/4 —	5/8 —	3/8
FP1-31	.25	600	"	"	"
FP1-32	.5	100	1 1/2 —	1/2 —	1/4
FP1-33	.5	200	1 1/2 —	5/8 —	3/8
FP1-34	.5	400	1 1/2 —	1 —	5/8
FP1-35	1.0	50	1 1/2 —	5/8 —	3/8
FP1-36	1.0	100	1 1/2 —	1 —	5/8
FP1-37	1.0	200	1 1/2 —	1 —	1
FP1-38	1.0	400	1 1/2 —	1 —	1
FP1-39	2.0	50	1 1/2 —	7/8 —	3/8
FP1-40	2.0	100	1 5/8 —	1 —	5/8
FP1-41	4.0	50	1 5/8 —	1 1/8 —	7/8
FP1-42	4.0	100	1 5/8 —	1 1/4 —	1
FP1-43	4.0	200	1 5/8 —	1 1/2 —	1
FP1-44	4.0	400	1 5/8 —	1 1/2 —	1
FP1-45	6.0	50	1 5/8 —	1 1/2 —	1

CAT. NUMBER	CAP. MFD	WORK VOLTS	DIMENSIONS LENGTH	DIAMETER
RP2-1	.00005	600	1/2 —	3/16
RP2-2	.0001	600	"	"
RP2-3	.00025	600	"	"
RP2-4	.0005	600	"	"
RP2-5	.001	200	"	"
RP2-6	.001	600	1/2 —	1/4
RP2-7	.002	200	1/2 —	3/16
RP2-8	.002	600	5/8 —	1/4
RP2-9	.003	200	1/2 —	3/16
RP2-10	.003	600	1/2 —	1/4
RP2-11	.005	200	5/8 —	3/16
RP2-12	.005	600	3/4 —	1/4
RP2-13	.005	600	"	"
RP2-14	.01	200	"	"
RP2-15	.01	600	3/4 —	1/4
RP2-16	.01	600	"	"
RP2-17	.02	200	"	"
RP2-18	.02	600	3/8 —	3/8
RP2-19	.02	600	"	"
RP2-20	.03	200	"	"
RP2-21	.03	600	"	"
RP2-22	.05	200	"	"
RP2-23	.05	600	3/4 —	1/2
RP2-24	.075	600	3/4 —	3/16
RP2-25	.1	200	3/4 —	3/8
RP2-26	.25	200	1 —	3/8
RP2-27	.5	200	1 1/2 —	1/2
RP2-28	1.0	200	1 1/2 —	3/4
RP2-29	2.0	100	1 1/2 —	1

WRITE FOR SAMPLES AND INFORMATION NOW

CAT. NUMBER PCM PBM	CAP. MF.	100 V D X L	CAT. NUMBER PCM PBM	200 V D X L	CAT. NUMBER PCM PBM	400 V D X L
1	.0001	3/16 — 1/2	21A	3/16 — 1/2	41A	1/4 — 7/8
2	.00025	" "	22	" "	42	" "
3	.0005	" "	23	" "	43	" "
4	.001	" "	24	3/16 — 7/8	44	" "
5	.002	" "	25	3/16 — 7/8	45	" "
6	.003	" "	26	" "	46	" "
7	.004	" "	27	" "	47	5/16 — 7/8
8	.005	" "	28	" "	48	" "
9	.01	3/16 — 7/8	29	1/4 — 7/8	49	" "
10	.015	" "	30	" "	50	" "
11	.02	1/4 — 7/8	31	5/16 — 7/8	51	3/8 — 7/8
12	.025	" "	32	" "	52	7/16 — 7/8
13	.03	5/16 — 7/8	33	" "	53	1/2 — 7/8
14	.04	" "	34	1/2 — 7/8	54	9/16 — 1 1/8
15	.05	3/8 — 7/8	35	" "	55	5/8 — 1 1/8
16	.1	7/16 — 7/8	36	1/2 — 1 1/8	56	" "
17	.15	1/2 — 1 1/8	37	5/8 — 1 1/2	57	3/8 — 1 1/2
18	.2	9/16 — 1 1/8	38	" "	58	" "
19	.25	" "	39	" "	59	11/16 — 2
20	.5	5/8 — 1 5/8	40	5/8 — 2	60	3/4 — 2
21	1.0	3/4 — 1 5/8	41	3/4 — 2	61	3/4 — 3

DUMONT ELECTRIC CORP. 308 DYCKMAN ST. NEW YORK, N. Y.

Do you have This Helpful Helipot and Duodial Catalog?

Do you have complete data on the revolutionary new HELIPOT—the helical potentiometer-rheostat that provides many times greater control accuracy at no increase in panel space?... or on the equally unique DUODIAL that greatly simplifies turns-indicating applications? If you are designing or manufacturing any type of precision electronic equipment, you should have this helpful catalog in your reference files...

It Explains – the unique helical principle of the HELIPOT that compacts almost four feet of precision slide wire into a case only 1¼ inches in diameter—over thirty-one feet of precision slide wire into a case only 3½ inches in diameter!

It Details – the precision construction features found in the HELIPOT... the centerless ground and polished stainless steel shafts—the *double* bearings that maintain rigid shaft alignment—the positive sliding contact assembly—and many other unique features.

It Illustrates – describes and gives full dimensional and electrical data on the many types of HELIPOTS that are available... from 3 turn, 1" diameter sizes to 40 turn, 3" diameter sizes... 5 ohms to 500,000 ohms... 3 watts to 20 watts. Also Dual and Drum Potentiometers.

It Describes – and illustrates the various special HELIPOT designs available—double shaft extensions, multiple assemblies, integral dual units, etc.

It Gives – full details on the DUODIAL—the new type turns-indicating dial that is ideal for use with the HELIPOT as well as with many other multiple-turn devices, both electrical and mechanical.

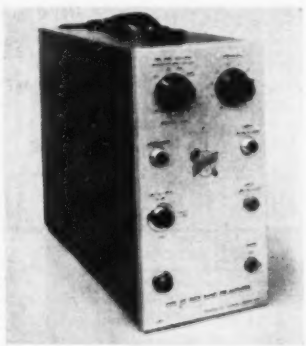
If you use precision electronic components in your equipment and do not have a copy of this helpful Helipot Bulletin in your files, write today for your free copy.

THE Helipot CORPORATION, SOUTH PASADENA 2, CALIF.

rent, 10 ma; maximum d-c load current, 1 ma; and maximum supply voltage frequency, 300 kc. Overall height is 2 11/16 in.

Ceramic Capacitors

CENTRALAB DIVISION OF GLOBE-UNION INC., 900 Keefe Ave., Milwaukee 1, Wis. The new line of ceramic BC Hi-Kap capacitors may be had in 48 different values and four sizes, with tolerances of 20 percent from 10 $\mu\mu$f through 2,200 $\mu\mu$f, and guaranteed minimum values from 2,500 $\mu\mu$f through 10,000 $\mu\mu$f. They are rated at 600 working volts d-c and are flash tested at 1,000 volts.



Wide-Band Preamplifier

TEKTRONIX INC., Portland, Oregon. Type 121 wide-band preamplifier was designed primarily to increase the sensitivity of types 511, 511-A and 511-AD c-r oscilloscopes. Maximum gain of 100, plus the combined attenuator and gain controls, permit a sensitivity range from 2.5 mv per cm to 25 v per cm without

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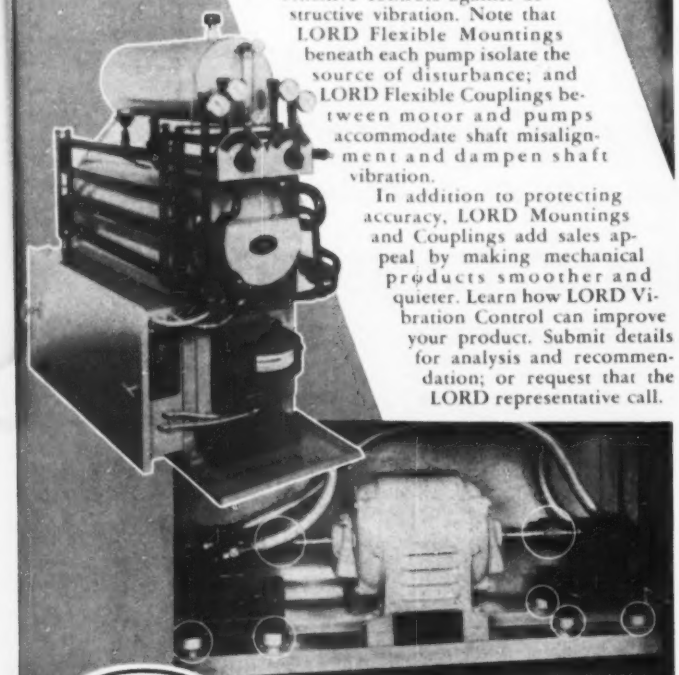
Precision of temperature control is the basis for uniform quality in many products. Typical of the equipment which automatically maintains process temperatures within close limits under varying load conditions is the Royle Temperature Control Unit shown here!

It is also typical of modern equipment design that LORD products are used to protect sensitive controls against destructive vibration. Note that LORD Flexible Mountings beneath each pump isolate the source of disturbance; and LORD Flexible Couplings between motor and pumps accommodate shaft misalignment and dampen shaft vibration.

In addition to protecting accuracy, LORD Mountings and Couplings add sales appeal by making mechanical products smoother and quieter. Learn how LORD Vibration Control can improve your product. Submit details for analysis and recommendation; or request that the LORD representative call.

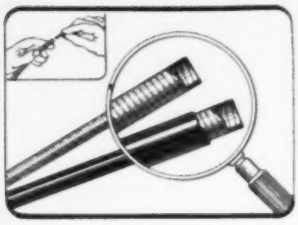


LORD BONDED RUBBER Vibration Control

LORD MANUFACTURING COMPANY · ERIE, PA.

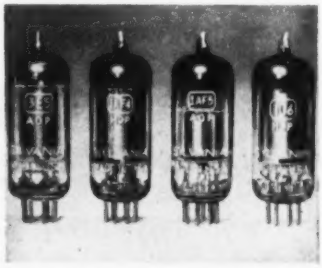
Canadian Representative: Railway & Power Engineering Corp. Ltd.

the use of attenuators on the oscilloscope. The bandwidth, in excess of 10 mc, preserves the rise time of the oscilloscope.



Wire Shielding

KUPFRIAN MFG. CO., 218 Prospect Ave., Binghamton, N. Y. A vinyl-covered Monocoil wire shielding supplements the full line of flat-wire, helically-wound types. Advantages reside in preventing grounding of the casing at more than one point, or in providing high-voltage insulation. Complete description and a chart showing full range of sizes appears in bulletin 5065.



Portable Radio Tubes

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Avenue, New York 18, N. Y. The new tubes illustrated enable A batteries in portable receivers to last about three times as long as with other available tubes. These low-drain tubes include type 1U6, a heptode converter with oscillator anode as a separate element; type 1AF5, a diode pentode; type 1AF4, a sharp cutoff r-f pentode; and type 3E5, a beam-power output tube. All have 25-ma filaments and 7-pin miniature button bases. Power required is 2.1 w or one-half the average required for other avail-

THE ONE 3-INCH TUBE

combining these modern features

for "HAIR-LINE" performance

Here is the modern achievement in a compact, three-inch cathode-ray tube providing the brilliant, "hair-line" trace long desired for best performance of portable oscillographs and industrial cathode-ray monitoring devices.

With performance at the highest premium, the special features of the DuMont Type 3RP-A have been combined to make high sensitivity compatible with short overall length; and to obtain a fine trace free from the distortions usually found in short tubes as sensitive as the Type 3RP-A.

Because of the new, ingenious design of the vertical deflection plates of the Type 3RP-A, the position of the cathode-ray beam does not affect deflection sensitivity, thereby substantially eliminating pincushioning and trapezoidal distortions.

New production techniques are applied for the first time to the commercial production of three-inch cathode-ray tubes to obtain a flat face which provides more usable screen area, eliminates parallax distortion, and carries through the high performance standard set by the advanced design of the Type 3RP-A electron gun.

COMPACT DESIGN . . .
Maximum length of 9⅛ inches plus high sensitivity.

BALANCED DEFLECTION . . .
For uniform spot focus maintained over the entire trace.

CURVED DEFLECTION PLATES . . .
For uniform deflection sensitivity.

FLAT FACE . . .
For more usable screen area with minimized parallax distortion.

"HAIR-LINE" TRACE . . .
Provided by small spot and fine focus.

Electrical Data

Heater Voltage	6.3 Volts
Heater Current	0.6 ±10% Ampere
Focusing Method	Electrostatic
Deflecting Method	Electrostatic
Phosphor	P1
Fluorescence	Green
Persistence	Medium

Typical Operating Conditions

For Anode No. 2 Voltage of	1,000	2,500 Volts
Anode No. 1 Voltage for focus	165 to 310	330 to 620 Volts
Grid No. 1 Voltage	−22.5 to −67.5	−45 to −135 Volts
Deflection Factors:		
D1D2	73 to 99	146 to 198 Volts D-C per Inch
D3D4	52 to 70	104 to 140 Volts D-C per Inch
Anode No. 1 Voltage for focus		16.5% to 31% of Eb2 Volts
Grid No. 1 Voltage		2.25% to 6.75% of Eb2 Volts
Anode No. 1 Current for any operating condition		−15 to +10 Microamperes
Spot Position (Undeflected)		Within 15 Millimeters square

DUMONT
for
Oscillography

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ALLEN B. DUMONT LABORATORIES, INC. INSTRUMENT DIVISION 1000 MAIN AVENUE CLIFTON, NEW JERSEY

"THE PROOF . . . of the Pudding"

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The proof lies in the satisfaction of the ultimate user . . . . . .

We are specialists in coil winding. For 32 years Coto-Coil has supplied leading manufacturers with coils for many uses. To meet temperature extremes . . . humidity . . . vibration . . . shock. Precision windings for delicate controls.

We have the engineering ability, a modern plant, latest equipment and skilled personnel to produce coils that are "right" . . . to assure delivery and to satisfy as to price.

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And We Shall Be Glad to Quote

BOBBINS
ACETATE INTERLEAVE (Coalesced)
PAPER INTERLEAVE
COTTON INTERWEAVE
TAPED FORM WOUND
UNIVERSAL SINGLE or MULTI-PIE CROSS WOUND

COTO-COIL CO. INC
COIL SPECIALISTS SINCE 1917
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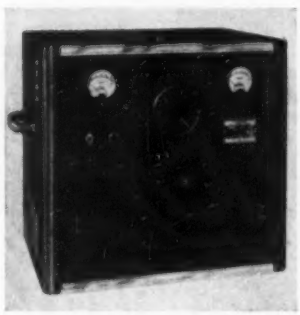
PROVIDENCE 5, R.I.

able types. The tubes will also operate over a range of 1.4 to 1.1 v.

Alkaline Storage Battery

YARDNEY ELECTRIC CORP., 105 Chambers St., New York 7, N. Y. The Silver-cell alkaline storage battery uses silver and zinc as active materials. It is one-third to one-fifth the weight of commonly used batteries, and one-half to one-third the bulk. Ampere-hour efficiency approaches 100 percent and energy efficiency is 85 percent. An important feature of the battery is its great resistance to mechanical shock. Five types now available range from 0.5 ampere-hour to 40 ampere-hour capacity.



D-C Power Supply

THE SUPERIOR ELECTRIC CO., Hannon Ave., Bristol, Conn. The Varicell provides a stabilized and regulated source of variable d-c voltage from a-c power lines. It operates from a 95 to 135-volt, 60-cycle, single-phase a-c line; delivers a d-c output variable from 0 to 30 v. Allowable output current available at any voltage setting is 15 amperes. Stabilization and regulation are given as 0.25 percent for an output

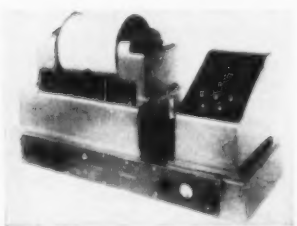
setting between 6 and 30 v. The rms ripple voltage does not exceed ±0.1 v.

TV High-Voltage Tester

OAK RIDGE PRODUCTS, 239 E. 127th St., New York 35, N. Y. Model 102 miniature tv high-voltage tester features a precision 10,000 ohms per volt movement and three scales: 0 to 500 v, 0 to 15 kv, and 0 to 30 kv, and comes complete with special high-voltage test lead. It measures 5¾ in. × 4 in. × 2¼ in.

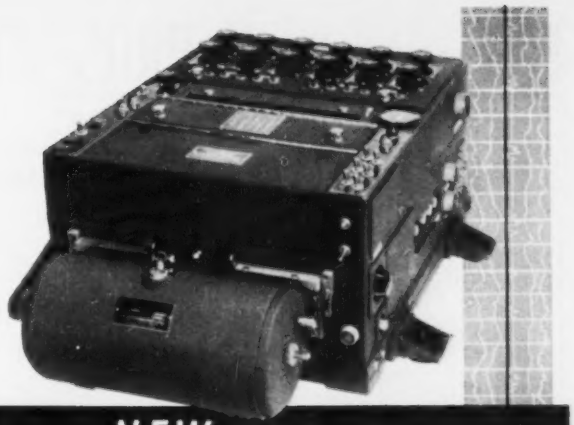
Tele Antenna

TECHNICAL APPLIANCE CORP., Sherburne, N. Y. Type 900 television antenna features four driven elements, two in the vertical plane and two in the horizontal plane, in place of parasitic elements, thus giving far greater control of the field pattern, and also permitting lobe switching. With this design it is possible by means of a diplexer network to eliminate entirely cochannel interference. Front-to-back ratio ranges up to 20 to 1.



Infrared Spectrophotometer

THE PERKIN-ELMER CORP., Glenbrook, Conn. Model 21 double-beam



the *NEW* S-8 Oscillograph

Here, in a versatile instrument of advanced design, are all the things you need for complete oscillographic recording. The Hathaway Type S-8 Oscillograph, which has long been the standard of oscillographic recording, has been improved to meet the rapidly expanding demands of modern research. Whether your measurement problems are simple or complex, the NEW Type S-8 Oscillograph has the inherent capabilities necessary to measure vibration, pressure, acceleration, and strain with new ease and accuracy.

The newest features include:

QUICK-CHANGE TRANSMISSION *fully enclosed with gears running in oil* **to provide instantaneous selection of 16 record speeds over the range of 120:1**

CHART TRAVEL INDICATOR provides continuous indication of chart motion. Operator knows instantly by flashing lamp if anything should happen to interfere with chart motion

FULL-RESILIENT MOUNTING FOR MOTOR AND TRANSMISSION isolates all possible vibration and makes possible the use of modern super-sensitive galvanometers

NEW GALVANOMETER STAGE accommodates all Hathaway galvanometer for recording milliamperes, microamperes, or watts

NEW RECORD-LENGTH CONTROL AND NUMBERING SYSTEM designed for long, trouble-free service under all kinds of ambient conditions

All the other valuable features are retained, such as

PRECISION TUNING-FORK-CONTROLLED TIMING SYSTEM produces either 1/10-second or 1/100-second time lines across sheet

WIDE RANGE OF GALVANOMETER TYPES AND CHARACTERISTICS provide for almost any recording requirements. Natural frequencies to 10,000 cps. Sensitivities to 50,000 mm per ma, single and polyphase watts

DAYLIGHT LOADING AND UNLOADING RECORDS TO 200 FT. IN LENGTH, width to 10 inches

SIMULTANEOUS VIEWING AND RECORDING

AUTOMATIC BRILLIANCY CONTROL

12 TO 92 ELEMENTS

Whatever your needs may be, investigate the NEW Type S-8 Oscillograph and its 170 types of galvanometers — the most versatile equipment in existence for general-purpose applications.

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Low loss insulators for all frequencies in standard stock shapes or special designs

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REQUIREMENTS:

Special Airborne-type Transformer

✓	PERMAFIL-IMPREGNATION
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✓	GREATER OUTPUT PER POUND
✓	400 TO 2400 CYCLES
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Vacuum-impregnated, HIPERSIL core, open or cased transformers to meet exacting electrical requirements in any given case size. Special design skills, premium materials, painstaking manufacture of custom units. If you have a transformer problem, consult us immediately.

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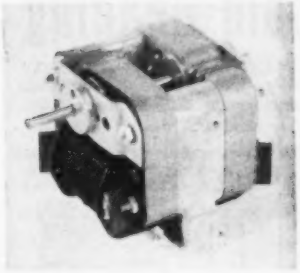
TELEPHONE DANBURY 4000

infrared spectrophotometer records directly in percent transmission against a linear wavelength scale on large charts, and is useful in both academic and industrial laboratories. Speed of scanning ranges from 3 minutes to 100 hours for the rock-salt region. Time of response varies from a few seconds to more than a minute for full-scale deflections. Overall range is from less than 2 microns to 15 microns in the rock-salt region. Chart scales are uniform from 1 to 50 in. per micron by integral factors; and chart size, about 32 × 11 in.



Tandem Motors

BARBER-COLMAN CO., Rockford, Ill. For wire recorders, vending machines and other applications requiring a reversible motor, the DYAB tandem units have high torque and excellent speed-torque characteristics. Maximum output is 0.004 hp. They feature propor-

AMPLISTAT designed for educational use demonstrates magnetic amplifier principle, facilitates experiments in motor-speed control, consists of a saturable reactor and rectifiers. *General Electric Company, Schenectady 5, N. Y.*

PRECISION
RECORDING WITH THE
Variplotter

The Model 205 Variplotter, highlighting accuracy, speed, and versatility, brings to industry and laboratory a new tool with a wide field of application. This instrument will present on a 30-inch square plotting surface a precise graphic representation of one variable as a function of another variable, requiring only that the variables be expressed by d-c voltages.

ACCURACY The static accuracy is .05 percent of full scale at 70°F. The dynamic accuracy averages .05 percent of full scale plus the static accuracy at a writing speed of 8½ inches per second.

SENSITIVITY The standard sensitivity of the Variplotter is fifty millivolts per inch with other ranges of sensitivity available.

RESPONSE The maximum pen and arm accelerations are 350 and 150 inches per second squared, respectively. Slewing speeds of both pen and arm are 10 inches per second.

The Variplotter may be adopted for special use by the addition of accessories selected from our standard line — such as multiple variable conversion kits, low-drift d-c amplifiers, analog computer components; or components designed for your specific need.

YOUR INQUIRIES ARE CORDIALLY INVITED.

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LONG BRANCH NEW JERSEY

KEEPING PACE
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ELECTRONIC NEEDS

. . . Our New Plant's Expanded Manufacturing, Technical Facilities

Now we can serve you even better . . . faster. A modern equipped plant and laboratory; latest production methods, and trained technicians provide a more systematized and complete operation. Products are constantly being created and tested to offer you the latest and best in electronic equipment.

New Model "B" Supplies 1 to 20 Amps 6 Volts DC, Continuous Duty
3 to 9 Volts at Other Ratings

New conduction cooling method increases rectifier power rating 1½ times, providing lower cost per ampere output over any other type. The Electro "B" gives you highest efficiency, offering ample power to operate two auto radios simultaneously. Peak instantaneous current rating of 35 amperes (from 50 to 60 cycle 115 volt power source).

APPLICATIONS
Tests or operates any 6 volt radio, relays, telephone circuits, laboratory instruments and many other low voltage requirements.

FEATURES
Less than 3% AC ripple or hum. Damped volt and ammeters (no wiggling) voltmeter 3% accuracy. Heavy duty selenium rectifiers, switch, transformer and choke. 6000 mfd. filter condenser.

Send for Folder on Complete Line

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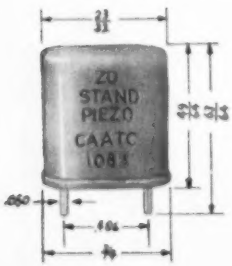
CUT COSTS

IN FREQUENCY CONTROL DESIGN . . . with STANDARD Type 20

±.002 %
—55°C to +90°C



Improved processing of our hermetically sealed TYPE 20 Unit has made it possible to eliminate the cost of temperature control.

Type 20 meets all government specifications.

Lower power requirements, reduced weight, compactness, aging, ruggedness, and dependability in our improved TYPE 20 is your answer for reducing costs and increasing sales.

For complete details, write for Engineering Data.

Standard Piezo Company
CARLISLE PA.

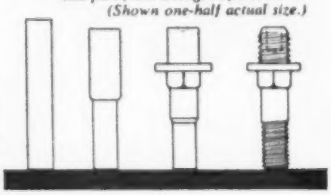
this complex shape is being made at low cost by ...

actual size

Cold Heading

This special steel stud, used in heavy duty power transmission equipment, combines two different shapes with four diameters.

Some of the steps involved in cold heading this part from a length of steel wire. (Shown one-half actual size.)



Production of this steel part by ordinary methods would involve the use of high cost machines, plus other costly operations. Cold heading not only provides economy and speed of production, but also produces a much stronger part.

Possibly this special technique can help *you* with your fastener problems. Send your sample or blueprint to Scovill *first*.

"Guide to the Profitable Use of Cold Heading"—Bulletin No. 2 describes the advantages and limitations of this process. It's free for the asking.

Recessed Head Screws • Sems
Tapping Screws • Standard
Machine Screws • Special Cold
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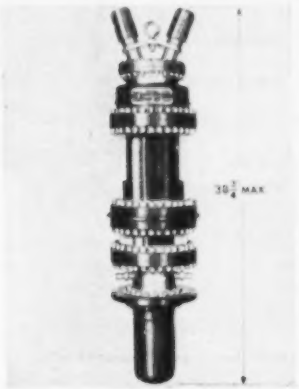
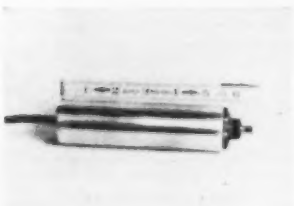
tioned field and concentricity of rotor in stator, centerless ground stainless steel shaft supported in wick-type bearings, and molded plastic spool. Units are available with several shaft diameters and various shaft extensions.



High-Power Beam Triode

RADIO CORP. OF AMERICA, Harrison, N. J. The 5831 superpower beam triode is capable of generating several hundred kilowatts of power at high efficiency and with exceptionally low driving power. It is primarily of importance in high-power c-w applications and in international broadcasting service. In unmodulated class-C service it has a maximum plate-voltage rating of 16,000 volts, a maximum plate input of 650 kw and a maximum plate dissipation of 150 kw. The tube requires less than 2 kw of driving power.



Torque Unit

SERVO-TEK PRODUCTS CO., 4 Godwin Ave., Paterson 1, N. J. The torque unit illustrated, for use in velocity servos and motor integrator sys-

FIRST SLIM TRIM DYNAMIC for TV

RESPONSE: 40-15,000 C.P.S. ± 2.5 DB

POWER RATING: −53

OMNIDIRECTIONAL

ACOUSTALLOY DIAPHRAGM

POP-PROOF HEAD

CHANGEABLE LOW IMPEDANCE

REMOVABLE SWIVEL

⅝" OR ⅝"-27 THREAD MOUNTING

CANNON XL-3 CONNECTOR

ALL PARTS PRECISION GROUND

Shows TV 655 suspended on a boom. Omnidirectional polar pattern and firm swivel permits easy, diverse use.

- New '655' Microphone Provides Ultra-Wide-Range, High Fidelity Response
- More Rugged, More Versatile
- Stops Wind and Breath Blasts
- Individually Laboratory Calibrated

Here, *for the first time*, you have a slim, trim microphone with all the advantages of *dynamic* performance and utility! Only because of the ingenious *Acoustalloy* diaphragm and other E-V developments has it become a reality! Meets the highest standards of TV, FM and AM.

You can use the *TV 655* on a stand, in the hand, or on a boom...or you can easily conceal it in studio props. *No additional closely-associated auxiliary equipment is required!* Provides effective individual or group pick-up. Reproduces voice and music with remarkable accuracy.

New E-V Blast Filter makes the *655 pop-proof*. Acoustically-treated, strong wire-mesh grille head stops wind and breath blasts. Eliminates wind rumble in outdoor pick-up. *Fully field tested and proved!* Ideal, too, for recording and high quality sound amplification.

See for yourself! Write today for Bulletin No. 156 and full information on how you can try this amazing new microphone.

Model 655. *List Price*.....**$200**

Shows the popular Patsy Lee with the TV 655. Note how swivel permits aiming at sound source without hiding face.

Shows TV 655 in the hand with swivel removed. Note how convenient it is to handle for announcing or interviewing.

Electro-Voice INC.

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The production testing of hermetically-sealed electronic components is a job which calls for a Consolidated Leak Detector. Minute leaks in seals are detected rapidly, easily and at low unit cost by the mass spectrometer method. Using helium as a probe gas, the components can be tested for leaks during the initial evacuation, and they can be tested after final sealing. There is no guesswork on meeting your specifications.

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For further information, write for Bulletin CEC 1801-X13.

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Analytical Instruments for Science and Industry

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how can YOU use this unique Edison Thermal Relay?

- For cathode protection
- —overload protection
- —holdovers
- —pulse integration
- —motor starting
- —or other control functions?

If you are designing circuits requiring a time delay element, or a reliable relay where a short operating interval can be tolerated, it might be to your advantage to consider the Edison 501 Thermal Relay.

Here are 7 good reasons why:

1. **Vibration and shock resistant** – Guaranteed to withstand continuous vibration of 1/16" over-all amplitude at 55 cps., and impact shock of 50 g.

2. **Chatter-proof** – Pre-loaded spring provides 50-gram pressure almost instantaneously, for sure, positive operation.

3. **Non-position sensitive** – Characteristics not affected by mounting angle – operates satisfactorily in any position. Standard intermediate octal base.

4. **Ambient compensated** – Automatically compensated for ±60° C. ambient range by extra unheated bimetal. Will operate from −60° C. to +100° C.

5. **Non-arcing** – Sealed-in-glass. Operates in its own arc-suppressing atmosphere. Withstands substantial currents and voltages without arc-pitting.

6. **Explosion-proof** – Hermetically sealed. You can specify it for safe use in corrosive or hazardous fumes and dusts. Tamper-proof, too.

7. **Fungus-resistant** – Available with fungus and salt-spray resistant micanol base.

GENERAL SPECIFICATIONS—STANDARD TYPES

Operating Time—5 to 300 sec., in 14 standard intervals, pre-set at factory.

Contacts—Silver, SPST, normally open.

Contact Rating—Types 5 sec. to 75 sec., 3 amp. 150 vdc or 250 vac. Types 90 to 300 sec. 3 amp. 450 v. ac./dc.

Heater—5 watts, 117 v., 26.5 v., 6.3 v., dc. or ac to 2400 cps.

Size—1.275" max. dia., 3.250" max. seated height, standard T-9 envelope.

Weight—1¼ to 2¼ ounces.

Other than standard types can be made up on special order to meet requirements for other heater voltages, higher currents, etc.

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INSTRUMENT DIVISION
THOMAS A. EDISON,
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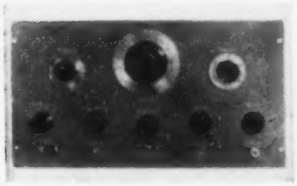
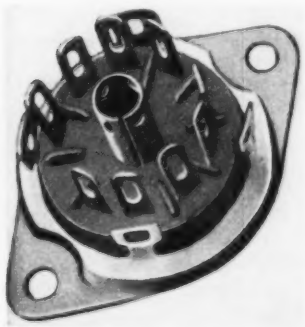
tems, consists of a permanent-magnet field-type 27.5-volt armature d-c motor with a d-c rate generator coupled to its high-speed shaft (10,000 rpm maximum). A 250-rpm maximum low-speed output shaft is coupled to the motor through suitable gear reductions. The torque unit motor supplies an output torque of approximately 6 in. per oz whereas tachometer output voltage per rpm is available in various models at from 2 to over 10 volts per 1,000 rpm of motor speed.



Pulse Generator

HEWLETT-PACKARD CO., 395 Page Mill Rd., Palo Alto, Calif. Model 212A general-purpose pulse generator was designed for radar, television and nuclear work. Among its outstanding features are a 0.02-μsec pulse rise and decay time, a 50-watt pulse, and a 0.07 to 10-μsec continuously variable pulse length. A low internal impedance of 50 ohms or less insures a pulse shape virtually independent of load. Repetition rate is continuously variable from 50 to 5,000 pps.



Miniature Tube Socket

MYCALEX TUBE SOCKET CORP., 30 Rockefeller Plaza, New York 20,

DESIGN and PRODUCTION

OF RELIABLE

MICROWAVE TRANSMISSION LINE COMPONENTS

is based on conservative engineering and long experience. The L. H. Terpening Company has both these assets. Starting 20 years ago in the field of parallel conductor lines, our engineers have been busy ever since then with UHF component problems; moving ahead with the art to stub supported coaxial lines and on to waveguides.

Together with this long experience, we have a top flight engineering staff, excellent laboratory, and controlled manufacturing facilities. We would appreciate an opportunity to discuss your present and future design and production problems.

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NEW!

FUNGUS-PROOF

Nylon LACING CORD

resists mold and micro-organisms

- Intensive research in the laboratories of Heminway & Bartlett has resulted in the development of a fungus-proof Nylon Lacing Cord. This new cord – with its special synthetic resin coating – resists the growth of mold and micro-organisms, factors most often responsible for the deterioration of old type linen and cotton lacing cord and the subsequent corrosion and failure of electronic equipment

Heminway & Bartlett's new special finish Nylon Lacing Cord retains the desirable malleability of wax and yet has a melting point of over 190°F. It is non-toxic to humans. We'll be glad to send you full information and prices . . . no obligation, of course. Why not write us today!

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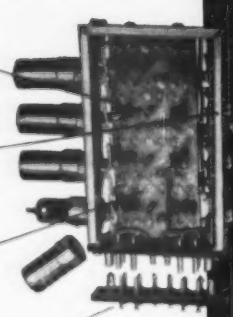
Potter decimal counter



Highest quality pretested components, conservative ratings

Four large, easy reading, bulls-eye glow lamps – replaceable socket type

All components turret-lug mounted and accessible . . . all wiring color coded

Special silver plated, self-aligning contact and rigid connectors for positive mechanical mounting

DIRECT DECIMAL READ-OUT — FOUR NEON GLOW LAMPS DESIGNATED 1-2-4-8 PROVIDE DIRECT INDICATION (0-9) AND INSTANTANEOUS LOCATION OF ANY DEFECTIVE TUBE.

STABLE OPERATION — WIDE VOLTAGE RANGE

HIGH COUNTING RATES — UP TO 130,000 PER SECOND ABSOLUTE ACCURACY GUARANTEED.

COVERED BY BOTH I.B.M. AND POTTER PATENTS ISSUED AND PENDING

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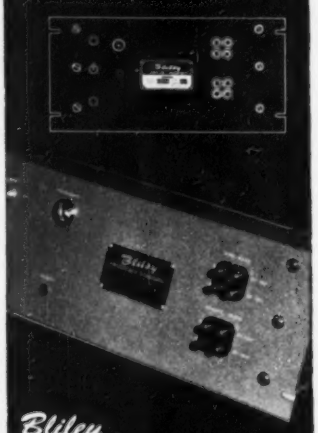

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TYPE
BCS-1A FREQUENCY STANDARD

Stability better than 2×10^{-7} over any 24 hour period

FOR THE FIRST TIME . . . A CO-ORDINATION OF ALL DESIGN FEATURES THAT CONTRIBUTE TO HIGH FREQUENCY STABILITY.

THE RIGHT COMBINATION AND BALANCE OF CIRCUITRY UTILIZING A SPECIAL BLILEY CRYSTAL AND TEMPERATURE CONTROL OVEN. A PRECISION REFERENCE INSTRUMENT WITH EXCEPTIONAL QUALIFICATIONS.

WRITE FOR BULLETIN 40D

A COMPLETE FREQUENCY STANDARD BY THE MAKERS OF

Bliley CRYSTALS

BLILEY ELECTRIC COMPANY
UNION STATION BUILDING
ERIE, PA

N. Y., announces the addition of a 9-pin miniature tube socket to its line. The sockets are obtainable in Mycalex 410 which was developed for applications requiring close dimensional tolerances not possible in ceramics and at much lower loss factor than mica-filled phenolics; and in Mycalex 410X which has been developed to compare favorably with general-purpose Bakelite in economy but with a loss factor of only about one-fourth of that material.

UHF Sweep-Frequency Oscillator

POLYTECHNIC RESEARCH AND DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. Type 901 uhf sweep-frequency oscillator generates frequency-modulated r-f signals throughout the 470 to 890-mc range with a maximum power output of at least 2 volts. This will permit its use for the rapid and accurate alignment and test of receivers and tuners operating in the new uhf television band.

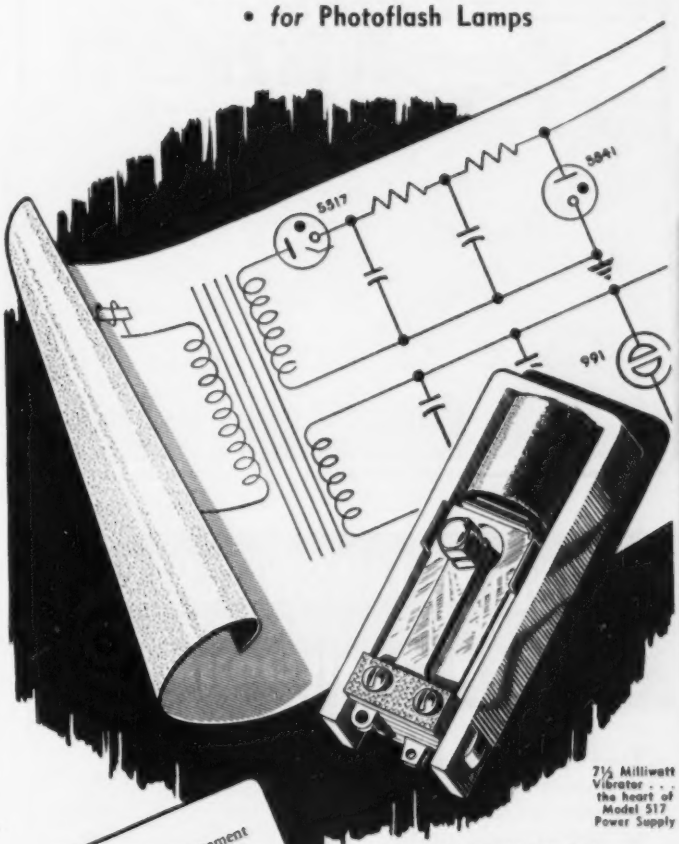
VHF Transmitter

LEAR, INC., AIRCRAFT RADIO DIVISION, 110 Ionia Ave. N.W., Grand Rapids 2, Mich. Model RT-10CP

Preview!

HIGH-VOLTAGE
VIBRATOR
POWER SUPPLY
by VICTOREEN

• *for* Geiger Counters
• *for* Photomultipliers
• *for* Photoflash Lamps



7½ Milliwatt Vibrator . . . the heart of Model 517 Power Supply

Another significant advancement in the "State of the Art" developed by the Research and Engineering Departments of The Victoreen Instrument Company.

CHARACTERISTICS

Input
Voltage Endpoint . . . . . 3.3 v
Current . . . . . 38 ma.

Output (1) Regulated
Voltage . . . . . 900 v
Current . . . . . 10 ua

Output (2) Regulated
Voltage . . . . . 60 v
Current . . . . . 0.5 ma.

THE VICTOREEN INSTRUMENT CO.
5806 HOUGH AVE., CLEVELAND 3, OHIO

WIRE
Made to Your Order

• Here are (1) Engineering and research facilities to work on your particular wire problems; (2) Production geared to any quality and quantity desired; (3) Unsurpassed craftsmanship; and (4) Wire that's made right
• Let us quote!

YOUR PRODUCT

HUDSON WIRE

Partial List of Products . . .

Bare Wire (Hudson Wire Division):
Copper. Brass. Bronze. Zinc. Silver plated. Tin. Phosphor-bronze. Nickel. Silver. Cadmium. Specialty Wires.

Insulated Wire (Winsted Division):
Enameled. Litz. Cement coated. Enameled. Cotton. Silk. Celanese. Glass fibre. Enameled Aluminum. Formvar. Loop Wire. Etc.

Winsted HUDCO

One of the Oldest Fine Wire Companies in America

HUDSON WIRE COMPANY

GENERAL OFFICES: OSSINING, N.Y. • WINSTED DIVISION: WINSTED, CONN.

New Type 2A TAP SWITCHES

HAVE A CONSTANT CONTACT RESISTANCE OF

ONLY 1 or 2 MILLIOHMS!

These high quality switches with up to 24 contacts were specifically developed to meet the need for rugged precision instrument switches that have longer operating life and are economical components in competitively priced electronic instruments and military equipment.

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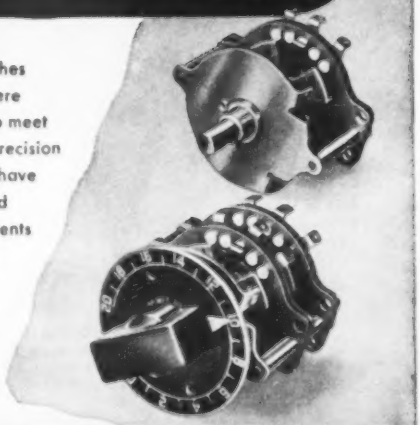
Write for Technical Bulletin No. 28.



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NEW JERSEY

Where the Requirements are Extreme . . .

Use SILVER GRAPHALLOY*

For extraordinary electrical performance

GRAPHALLOY
TRADE MARK REG. U. S. PAT. OFF.

THE SUPREME BRUSH AND CONTACT MATERIAL

IN BRUSHES

- for high current density
- minimum wear
- low contact drop
- low electrical noise
- self-lubrication

IN CONTACTS

- for low resistance
- non-welding character

* SILVER GRAPHALLOY is a special silver-impregnated graphite

Accumulated design experience counts — call on us!

GRAPHITE METALLIZING CORPORATION

1055 NEPPERHAN AVENUE, YONKERS 3, NEW YORK

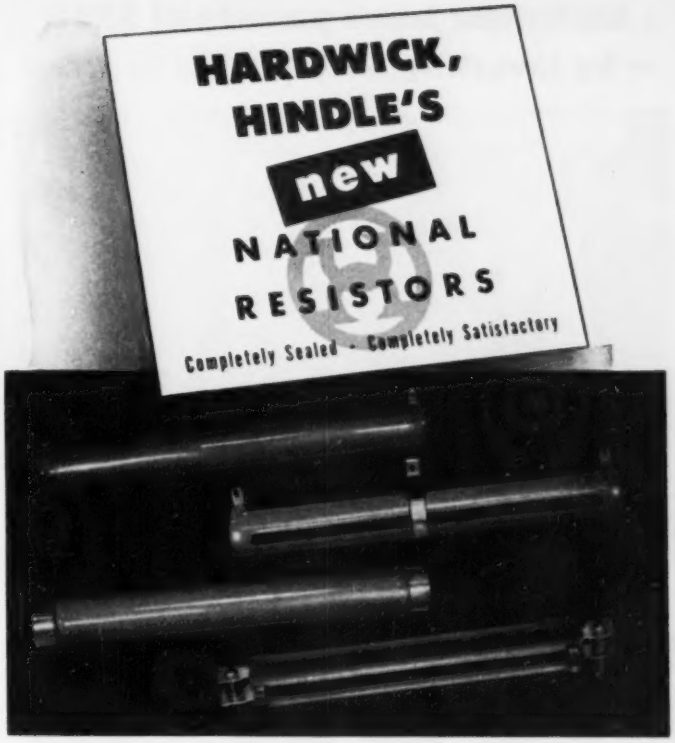
six-frequency vhf transmitter is designed to meet the minimum space requirement on an aircraft instrument panel. Radiated output is more than 2 watts. The unit weighs 10 oz, measures $2\frac{3}{8} \times 1\frac{1}{8} \times 7\frac{3}{4}$ in. overall.

Tele Field Strength Meter

APPROVED ELECTRONIC INSTRUMENT CORP., 142 Liberty St., New York 6, N. Y., has introduced the Model A-460 lightweight portable television field strength meter. The unit is calibrated from 50 to 30,000 μv. It is designed with self-contained power supply, 115 volts, 60 cycles.

Beam Power Amplifier

SYLVANIA ELECTRIC PRODUCTS INC., 500 Fifth Ave., New York 18, N. Y. Type 6AU5GT high-perveance beam-power amplifier is designed for use as a horizontal deflection amplifier in high-efficiency deflection circuits for tv receivers. Features include low-mu, high plate current at low plate voltage and high operating ratio of plate current to number 2 grid current. The



✓ the core is stronger, and has higher resistance to vibrations and shock.

✓ the resistance wire—made to H.H. specifications especially adapted to these resistors—is more uniformly wound so that failures under stress are eliminated.

✓ the special alloy terminals are more securely fastened to the ceramic body by spot-welding—highly resistant to corrosion.

✓ all wire connections are protected by a positive, non-corrosive bonding.

and...

✓ *new*—blue-gray enamel coating—crazeless, thermo-shockproof gives greater protection throughout the most rugged service—longer life under extremes of humidity, salt water and severest atmospheric conditions. And by withstanding higher heat these resistors afford a greater safety factor.

✓ The fixed, the ferrule and the flat types are especially designed for and manufactured in accordance with JAN-R-26A specifications.

SEND FOR NEW RESISTOR BULLETIN TODAY

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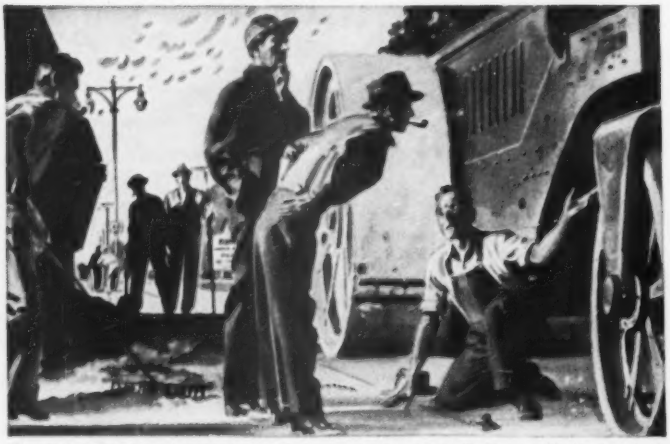
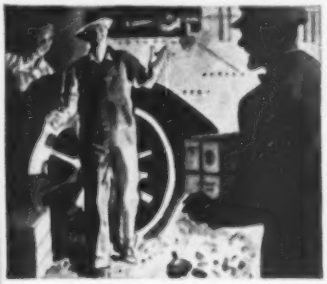
RHEOSTATS *and* RESISTORS
Subsidiary of
THE NATIONAL LOCK WASHER COMPANY
Established 1886
40 HERMON STREET NEWARK 5, N. J., U. S. A.

Contractor saves penalty of $500 —by investing $3.84 in Air Express



Time clause in housing project paving contract stood good chance of being invoked when equipment broke down at 5 P.M. So 10-lb. carton of replacement parts was Air Expressed from 1200 miles away. Delivered in just 8 hours. The Air Express charge was only $3.84—and contractor completed job on time.



$3.84 is small indeed, since it covers door-to-door service. Anytime delivery, 7 days a week. Makes the *world's fastest* shipping service the most convenient.

Air Express goes by Scheduled Airlines; extra dependability, *experienced* handling. Shipments keep moving. Regular use keeps *any* business moving.

Air Express gives you all these advantages

World's fastest shipping service.
Special door-to-door service at no extra cost.
One-carrier responsibility all the way.
1150 cities served direct by air; air-rail to 22,000 off-airline offices.
Experienced Air Express has handled over 25 million shipments.

Because of these advantages, regular use of Air Express pays. It's your best air shipping buy. For fastest shipping action, phone Air Express Division, Railway Express Agency. (Many low commodity rates in effect. Investigate.)

AIR EXPRESS
GETS THERE FIRST

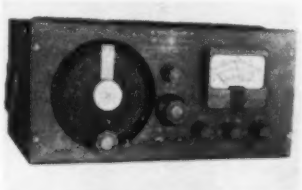
Rates include pick-up and delivery door to door in all principal towns and cities

A service of
Railway Express Agency and the
SCHEDULED AIRLINES of the U.S.

tube has a 6.3-volt, 1.25-ampere heater. Under typical operating conditions transconductance will be approximately 6,000 micromhos; mu, approximately 5.9. Maximum plate dissipation is 8 watts; peak positive pulse plate voltage is 4,500 v; and maximum d-c plate voltage, 450 v.

Power Transformer

SOLA ELECTRIC CO., 4633 W. 16th St., Chicago 50, Ill. Type CVE power transformer corrects line voltage variations of 100 to 130 volts to ±3 percent or less at its outputs. It provides high-voltage plate and filament windings (6.3 volts and 5 volts) on the same core.



F-M Modulation Monitor

BROWNING LABORATORIES, INC., 742 Main St., Winchester, Mass. Model MD-25 modulation monitor is designed to cover 30 to 50 mc, 72 to 76 mc, and 152 to 162 mc in four bands making it possible for the one instrument to be used in checking transmitters on widely separated frequencies or on different bands. Coarse and fine tuning controls permit precise adjustment to the carrier frequency. Either upward or downward swing can be measured up to 20 kc with an ac-

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in handy 5-ounce packets . . .

Now you can get this versatile, fast-acting low-temperature silver brazing alloy in convenient, sturdy 6½" square packets. Just the thing for—small shops—plumbers—refrigeration, electrical and other service men—maintenance and repair crews, etc. Also for all shops that make ferrous and non-ferrous metal products for silver alloy brazing trial work, tool repairs, etc. Each package contains a 5-ounce coil of EASY-FLO 45 1/16" wire (approx. 330 lineal inches)—also torch brazing instructions and a "Quick Facts" folder giving full details about EASY-FLO 45.

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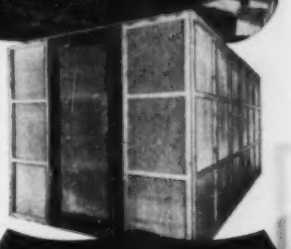
ON THE JOB AT THE FAMOUS BELL "LABS"

In this modern home of telephone research—the Bell Telephone Laboratories, Murray Hill, N. J.—Ace Screen Rooms play an important part in assuring maximum shielding efficiency for numerous test and research procedures.

Better Attenuation

. . . AT NO GREATER COST!

Designed to exacting wartime laboratory standards, supplied in ready-built "knock-down" form for installation in a few hours, Ace Screen Rooms provide a minimum of 100 db. attenuation from 0.15 to 1000 mc. Total cost is no greater than that of "homemade" screen rooms of far lower efficiency. Numerous sizes are available and rooms can readily be moved or enlarged as required. Write, wire, or 'phone for details.



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READY-BUILT "UNIT CELL"
SCREEN ROOMS

ACE ENGINEERING & MACHINE CO.
3642 N. Lawrence St.
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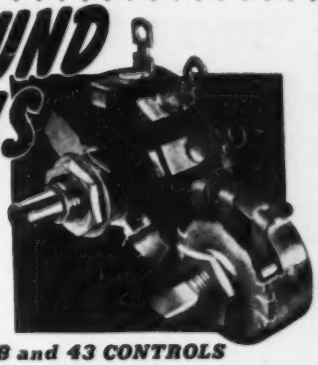
WIRE-WOUND CONTROLS



- ★ Winding skill second to none
- ★ Large and small controls
- ★ Velvety-smooth rotation, always
- ★ Minimized wear-and-tear
- ★ Taps and tapers. Tandem units

CLAROSTAT SERIES 58 and 43 CONTROLS

The large-sized Series 58 Clarostat rheostat or potentiometer offers laboratory-grade performance at mass-production cost. 1-21/32" dia. 1 to 100,000 ohms. 3 watts, linear. The finest standard wire-wound control made!

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Hundreds of thousands of Clarostat wire-wound controls are in daily use. Their performance, dependability and long life, are a matter of record.

Ask for Bulletins 116 and 118.
Let us quote on your needs.

CLAROSTAT *Controls and Resistors*

CLAROSTAT MFG. CO., INC. • DOVER, NEW HAMPSHIRE • *In Canada:* CANADIAN MARCONI CO., LTD. Montreal, P.Q., and branches

Workmen of Conlan Electric Corp., Brooklyn, N. Y., protect TV antenna lead-in with "SCOTCH" No. 33 Electrical Tape.

5¢ worth of plastic tape may save a $5 TV trouble call

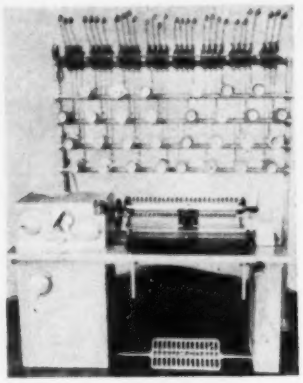
"SCOTCH" No. 33 Electrical Tape cuts expensive maintenance trouble for TV specialists like the Conlan Electric Corp., Brooklyn, N. Y. This tough, weather resistant tape gives lasting protection to antenna lead-in wires and harnesses. Plastic backing seals out moisture, prevents snow and ghosts. Many times a 5 cent piece of "SCOTCH" No. 33 Plastic Tape may save a 5 dollar service call.

Whatever your insulating problem, this tough plastic tape can save you maintenance time and money. It's fast—goes on at a touch. Stretchy—conforms snugly to uneven surfaces. Write Dept. ES-550 today for complete information.

TIP—for perfect high-heat insulation try "SCOTCH" Electrical Tape No. 27 with Glass Cloth backing, thermosetting adhesive.

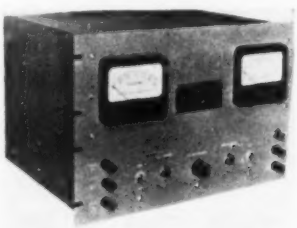
Made in U. S. A. by **MINNESOTA MINING & MFG. CO.**, St. Paul 6, Minn.
also makers of other "Scotch" Brand Pressure-Sensitive Tapes, "Scotch" Sound Recording Tape, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-Slip Surfacing, "3M" Abrasives, "3M" Adhesives.
General Export: DUREX ABRASIVES CORP., New Rochelle, N. Y.
In Canada: CANADIAN DUREX ABRASIVES LTD., Brantford, Ontario

curacy of better than 1 kc on a 4-in. meter.



Coil Winding Machine

UNIVERSAL WINDING CO., P. O. Box 1605, Providence 1, R. I., announces a manually-operated coil-winding machine designed for the production of paper insulated coils in multiple or stick form. A more positive lay of wire is provided by the unit's leadscrew gearing that is independent of traverse and is designed as a turns-per-inch system. Power is supplied by a ½ hp a-c constant speed motor driving through an adjustable-sheave speed controller to a multiple-disc friction clutch attached to the spind'e. Speed range is 400 to 2,200 rpm and speed selection is made by turning a crank on the front of the column.



Regulated Power Supply

AMERICAN ELECTRONEERING CO., 2112 South La Brea Ave., Los Angeles 16, Calif. The outstanding feature of the PSR-100 regulated power supply, a versatile laboratory instrument, is the regulation of the high-voltage output. Regulation is

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Again Atlas leads the field with its new line of speakers and projectors.

Again Atlas makes the news in the Sound System field.

Atlas Reproducer units continue to retain the famous "Atlas V Plus" super-efficient magnetic assembly and in addition many more "Extra Plus" features. A new reversed dome, blast proof diaphragm is now standard in the high power, high fidelity models. Built-in transformers, designed for either constant 70 volt or constant impedance audio circuits are included. Improved appearance—functionally designed for maximum convenience. Double seal weatherproofing. All this and more without any general increase in price.

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Write for our new catalog — the most complete line of speakers, microphone stands and sound accessories.

ATLAS SOUND CORPORATION
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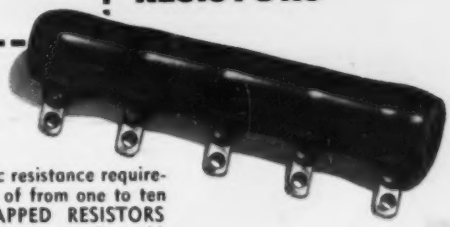
. . . Up to Ten Taps

LECTROHM TAPPED RESISTORS



Flexibility to specific resistance requirements, in variations of from one to ten taps. Lectrohm TAPPED RESISTORS are noted for quality *features* that add up to real efficiency. • Silver-soldered connections. • Vitreous enamel coatings. • Close tolerance. • Dependable stability. Standards from stock, or special designs. Another member of the famous *Lectrohm Line*. Remember, if you have a difficult resistance problem, Lectrohm engineering service is here to help.

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INCORPORATED

5903 Archer Ave. Chicago 38, Ill.
Division of
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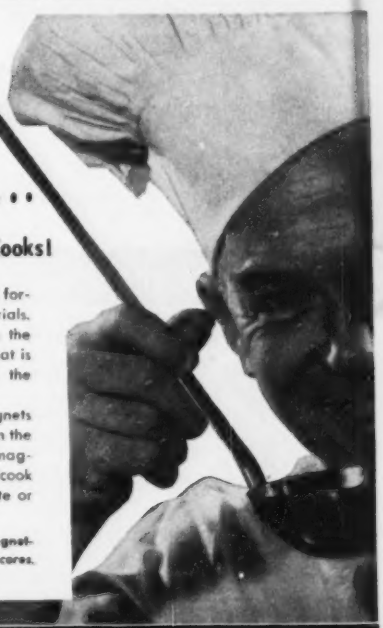
Same Recipe...

But Oh, What a Difference in Cooks!



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Thomas & Skinner permanent magnets reflect our 49 years of experience in the design and fabrication of the right magnet for every application. Let us "cook up" the *right* magnet for you. Write or call us today.

Thomas & Skinner—Specialists in magnetics: ***permanent magnets and laminated cores.***

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PRECISION TUNED CIRCUITS FOR YOUR SELECTIVE AMPLIFIER

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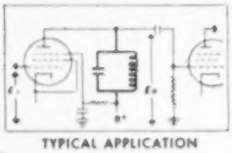
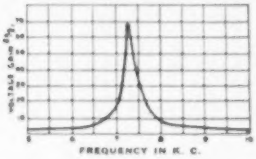
High Q precision tuned resonant circuits, accurately adjusted to your specified frequency. Toroid coil and capacitor are permanently protected by tough thermosetting plastic. Pigtail leads and light weight allow direct or terminal board mounting.

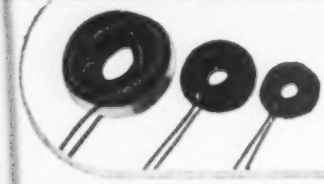


TYPICAL APPLICATION



FREQUENCY IN K. C.

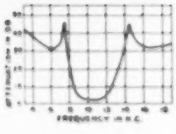
CUSTOM MADE TOROID COILS



Toroid coils, transformers and discriminators in a large range of inductances, frequencies and power levels. Permalloy dust cores. Uncased, mounted in hermetically sealed cans or coated with thermosetting plastic. Close tolerances with taps at any point. Multiple windings. Up to 2 Henries on wedding ring size. Larger sizes to 50 Henries.

MINIATURE TOROID FILTERS

1⅝" x 1⅛" x 2" HIGH



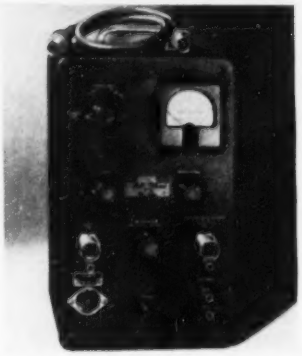
Specialized design and complete production facilities for your filter requirements. Where space is critical, miniature filters with wedding ring toroids and special capacitors. Supplied in standard units, or designed to your specification. A miniature band pass filter and curve are shown.

RAPID PRODUCTION DELIVERY. Engineering requirements given special attention. Wire, phone or write complete specifications.

COMMUNICATION ACCESSORIES Company

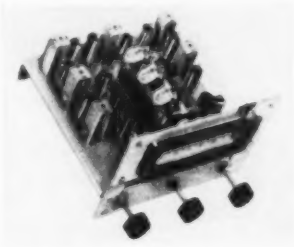
HICKMAN MILLS, MISSOURI

0.5 percent for any output voltage from 30 to 500 volts d-c under any load conditions from 0 to 300 ma, and any line-voltage variations from 105 to 125 volts a-c. Ripple voltage is less than 10 mv peak-to peak at maximum rated voltage and load; impedance, effectively zero at any frequency; ambient temperature rise, approximately 30 C.



Amplitude Modulator

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1023-A amplitude modulator is designed for use with signal generators for receiver tests where a-m is desired with negligible incidental f-m. Modulation up to 80 percent at 60 cycles is provided internally. External modulating frequencies between 20 cycles and 15 kc can be used. Input and output impedances are 50 ohms. Radio-frequency range is 10 mc to 150 mc with a gain of 0.1 and 10.1 mc to 11.3 mc with a gain of 10.

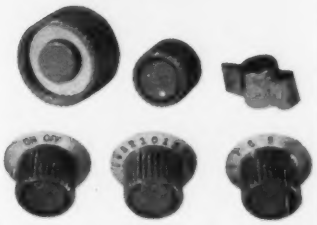


F-M A-M Tuner

APPROVED ELECTRONIC INSTRUMENT CORP., 142 Liberty St., New York 6,

NATIONAL

- Proven
- Dependable
- Quality



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These are the most popular knobs of their type ever designed—because of their clean, functional, chrome-and-plastic styling and because of their sturdy construction. All fit ¼" shafts. For commercial applications they can be supplied in quantity in special colors and with special calibrations.

There is a National quality knob and quality dial for every purpose. Write for new catalog of National components and equipment.

National

NATIONAL COMPANY, Inc.

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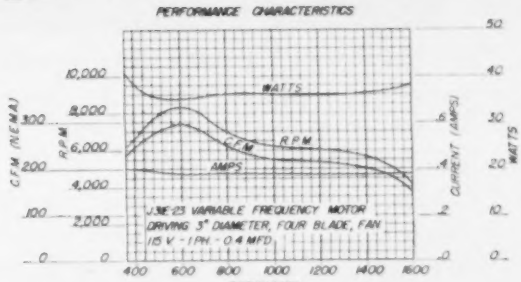
Looking for Something Special?

IN A VARIABLE FREQUENCY BLOWER

EAD HAS IT!

Our J31E-23: Designed to operate 50-60 cy. and 360-1600 cy.



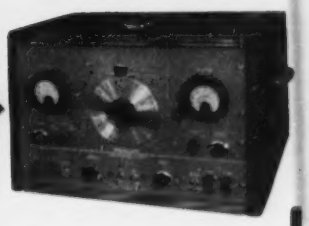
OPERATION @ 50 Cycles: .18 Amps—17 Watts—2600 RPM—90CFM.
OPERATION @ 60 Cycles: .18 Amps—15 Watts—3300 RPM—110CFM.

MINIMUM CHANGE IN CURRENT, POWER, DELIVERY AND SPEED OVER MAXIMUM FREQUENCY RANGE. SMALL SIZE—2" diameter x 3⅛".

EASTERN AIR DEVICES, INC. 585 DEAN STREET BROOKLYN 17, N.Y.

SYNTHESIS

IS A HIGH CLASS WORD FOR DESIGNING SERVO MECHANISMS



...SERVOSCOPE IS A HIGH CLASS INSTRUMENT FOR SERVO SYNTHESIS!

SERVO

WRITE FOR INFORMATION

- MEASURES amplitude & phase vs. frequency
- CARRIERS accepted, 50 to 800 cps
- MODULATES chosen carrier, 0.1 to 20 cps
- ANALYZES D.C. or A.C. automatic controls
- SUB-AUDIO sine generator, 0.1 to 20 cps
- SQUARE WAVE generator, 0.1 to 20 cps
- PHASE READING to 1° accuracy, 2 methods
- LINEAR SWEEP for external use, 0.1 to 20 cps

SERVO CORP. OF AMERICA
NEW HYDE PARK, N. Y.

Cut Polishing Time
Improve Surface Quality
with "LINDE" FINE ALUMINA POWDERS

Now, you can choose the type of finish you want, free from microscopic pits and scratches, on metallic and non-metallic surfaces. And you can get these superior results in a fraction of the usual polishing time by using ultra-fine LINDE abrasive powders.

Because of extremely uniform particle size and form, smaller amounts of LINDE Fine Alumina Powders go further. You can use them directly from the container without expensive preparatory steps—or compound them with waxes and other vehicles to suit your need.

Two types are available. Type A is a quick-acting powder of hexagonal structure and sapphire hardness. Type B produces a still finer polish, almost as quickly.

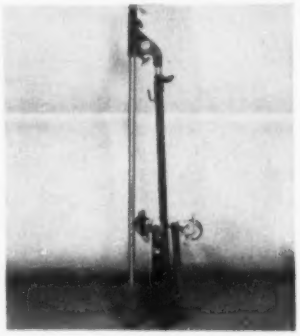
LINDE Fine Alumina Powders may be the answer to your polishing problems. They have already gained acceptance in polishing metallographic specimens, gemstones, and other materials. Call or write any LINDE office to find out how these powders can be used to advantage in your particular polishing applications.

The term "Linde" is a trade-mark of The Linde Air Products Company

	Type A	Type B
Chemical Composition	Alpha Al_2O_3	Gamma Al_2O_3
Particle Size (approximate)	0.3 Micron	Less than 0.1 Micron
Hardness (Mohs) (Equivalent to crystalline material)	9	8
Crystalline Structure	Hexagonal	Cubic

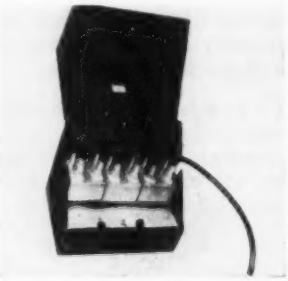
THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities
In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

N. Y. Model A-710 f-m/a-m tuner can be mounted in either horizontal or vertical positions with the appropriate scale supplied. It receives f-m broadcasts from 88 to 108 mc and a-m broadcasts from 540 to 1,800 kc. Power requirements are 170 volts d-c, 20 mils and/or 140 volts d-c, 37 mils, 6.3 volts, 4 amperes.



Studio Boom Stand

RADIO CORP. OF AMERICA, Camden, N. J. Type KS-3B lightweight boom stand for proper microphone positioning in broadcast and television studios is easily adjusted for heights from 5 ft 2 in. to 8 ft 8 in., with horizontal arm extensible from 3 to 6 ft. Once the stand is properly placed its casters can be secured by means of foot-operated locks.



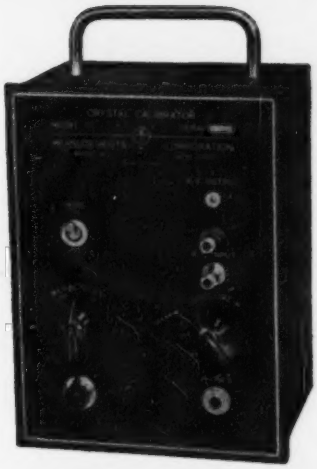
Master Antenna Distribution Assembly

LYNMAR ENGINEERS, 1721 Delancey St., Philadelphia 3, Pa. The No. PD-16 distribution equipment feeds six television receivers from one

CRYSTAL CALIBRATOR

MEASUREMENTS CORPORATION

Model 111



FREQUENCY RANGE .25Mc.—1000 Mc.

FREQUENCY ACCURACY 0.001%

A Dual-Purpose Calibrator

- **CRYSTAL-CONTROLLED OSCILLATOR**
- **CRYSTAL RECEIVER 2 Microwatt Sensitivity**

Designed for the Calibration and Frequency Checking of Signal Generators, Transmitters, Receivers, Grid-Dip Meters and other equipment where a high degree of frequency accuracy is required.

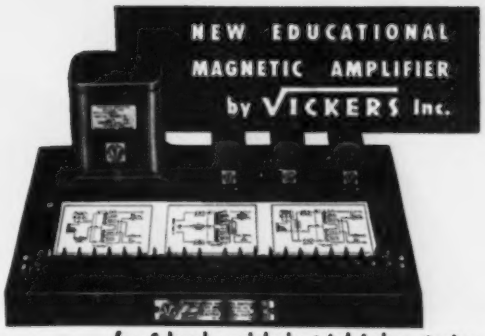
Harmonic Range:
.25 Mc. Oscillator: .25-450 Mc.
1 Mc. Oscillator: 1-600 Mc.
10 Mc. Oscillator: 10-1000 Mc.

117 volts, 50/60 cycles; 18 watts, 6" wide, 8" high, 5" deep; 4 lbs.

MEASUREMENTS CORPORATION

Boonton New Jersey

NEW EDUCATIONAL MAGNETIC AMPLIFIER by VICKERS Inc.



for School and Industrial Laboratories

- A unit designed by Vickers Electric Division to help students and industrial personnel obtain a wider knowledge of the characteristics and applications of high-performance self-saturating magnetic amplifiers.
- All three basic single-phase self-saturating circuits may be studied, and the educational unit can actually be used in operating controls circuits. Gives d-c or a-c output, uses d-c or a-c control power.
- Magnetic Amplifier Laboratory Manuals and Magnetic Amplifier Design Bulletins included with each educational unit.

Write for information and price.

VICKERS ELECTRIC DIVISION

VICKERS Inc.

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Over 1000 Sizes

PARAMOUNT SPIRAL WOUND PAPER TUBES

SEND FOR ARBOR LIST OF OVER 1000 SIZES

Convenient, helpful listing of over 1000 stock arbors. Includes many odd sizes of square and rectangular tubes. Write for Arbor List today. No obligation.

Square • Rectangular • Triangular
Round and Half-Round

With a wide range of stock arbors . . . plus the specialized ability to engineer special tubes . . . PARAMOUNT can produce the exact shape and size you need for coil forms or other uses. *Hi-Dielectric, Hi-Strength.* Kraft, Fish Paper, Red Rope, or any combination, wound on automatic machines. Tolerances plus or minus .002". Made to your specifications or engineered for YOU.

Inside Perimeters from .592" to 19.0"

PARAMOUNT PAPER TUBE CORP.

616 LAFAYETTE ST., FORT WAYNE 2, IND.

Manufacturers of Paper Tubing for the Electrical Industry

which one is the **PRESTO?**

It's hard to tell just by *looking* at a disc whether it's going to make a good recording... unless you see the PRESTO label. PRESTO discs are manufactured under dust-free, temperature-controlled conditions... in a plant where human hands never touch the glass-like surface of the disc. Meticulous preparation of the aluminum base, the choice of the finest lacquer, weeks of "curing" in the world's most modern disc plant... make PRESTO discs the finest you can buy.

Throughout the world, PRESTO discs have won engineers' acclaim for the best performance, having the most permanence, making the best masters or instantaneous recordings anywhere.

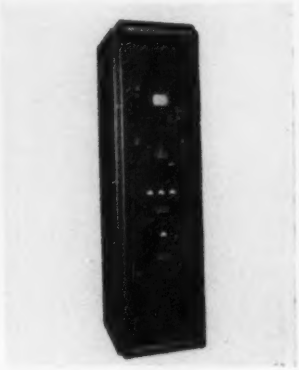
The next time you're in doubt about discs... look for the name PRESTO... your assurance of the finest your disc dollar will buy.

PRESTO
RECORDING CORPORATION
Paramus, New Jersey
Mailing Address:
Box 500, Hackensack, New Jersey

In Canada:
Walter P. Downs, Ltd.
Dominion Sq. Bldg.
Montreal, Canada

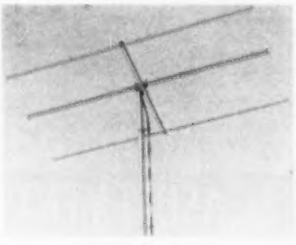
Overseas:
The M. Simons & Son Co., Inc.
25 Warren Street
New York, N. Y.

antenna system. It is composed of three coupling units, each of which feeds two tv sets, a power supply and a mounting cabinet. Operation is based on low-pass filter theory in which the filter elements are made up of the interconnections and internal circuit constants. Cutoff frequency is approximately 230 mc.



Spectrum Analyzer

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y. Model LSA direct-reading spectrum analyzer features continuous unidial tuning over the entire range with 5-kc resolution at all frequencies; a frequency which can be read to an accuracy of 1.0 percent; and dispersion, completely independent of frequency and variable from 250 kc to 25 mc. A 5-in. crt display unit, klystron power unit and low-voltage power unit are provided.

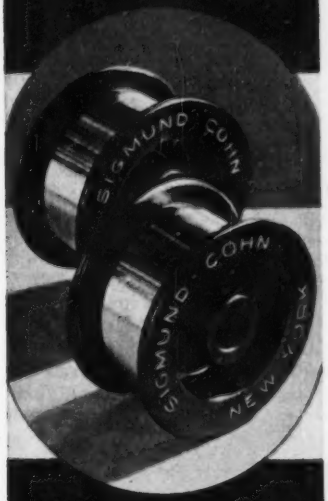


Three-Element Beam

THE LAPOINTE-PLASCOMOLD CORP., Unionville, Conn., is now in production on the model EC three-element

Gold Plated

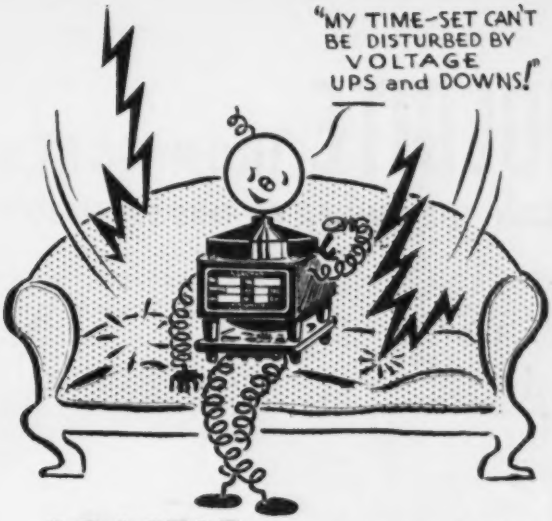
TUNGSTEN and MOLYBDENUM GRID WIRE



Made to meet your specifications for gold content and diameter . . .

Write for details and list of products

SIGMUND COHN CORP.
44 GOLD ST., NEW YORK
SINCE 1901



AGASTAT TIME DELAY RELAY

Readily adjustable . . . flexible . . . instantaneously recycling . . . small, compact and easily mounted.

Literature and information without obligation.

AGA AIRPORT LIGHTING · AGA MARINE LIGHTING EQUIPMENT · AGA TELEVISION REFLECTORS · AGASTAT TIME DELAY RELAYS

AMERICAN GAS ACCUMULATOR COMPANY
1027 NEWARK AVENUE • ELIZABETH 3, N. J.

We are Proud to Announce:

AN ENTIRELY NEW RECORDER WHICH WILL BE HIGHLY WELCOMED IN THE ELECTRO-ACOUSTICAL FIELD

This instrument combines—in ONE COMPACT UNIT—two complete recorders, a POLAR or angular Recorder AND a FREQUENCY RESPONSE Recorder.

Through an ingenious switching arrangement many recording combinations are possible: for instance angular patterns can be made on a polar OR linear chart. It is also possible to change the direction of recording, that is, record forward AND backward in rotary and / or linear motion. Oscillators, sound analyzers, auxiliary rotary devices like test turntables can be synchronized with either the linear or rotary motion of the recorder.

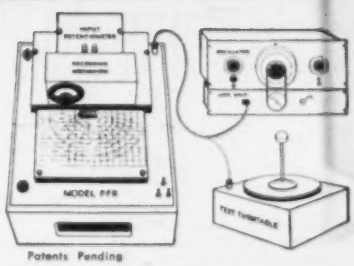
Three high-class synchronous motors produce the linear, the rotary, and the pen movements. Auxiliary apparatus like oscillators, etc. are connected to the recorder by specially designed LINK UNITS which are also operated by synchronous motors and can be placed and controlled remote from the recorder.

Another desirable feature in Model PFR is that either AC or DC voltages can be recorded. Special charts are available for either polar or frequency response (logarithmic) recording; but any standard chart or, in emergency, any 8½x11 sheet of paper can be used.

Recording ranges from 0-20 db to 0-80 db can be supplied; also available are Linear, Square Root, and Phon Input Potentiometers.

Literature will be mailed upon request.

Consult our engineering staff for special applications.



Patents Pending

Construction is extremely sturdy, employing newly developed linear ball bearings; motions are controlled by durable friction clutches, and non-corrosive materials are used throughout. The electronic chassis is an integral unit and can be disconnected in seconds. The recording mechanism also is an integral unit and is conveniently accessible. Service problems are practically non-existing on this recorder.

APPLICATIONS:
BEAM PATTERN PLOTTING of antennas, microphones, loudspeakers, lighting fixtures, ultrasonic devices; **FREQUENCY RESPONSE RECORDS** of microphones, loudspeakers, amplifiers, filters, radio and television circuits; **RECTILINEAR CURVES** on vacuum tubes, potentiometers, amplifiers, counting and computing devices.

MODEL PFR IS MOST MODERATELY PRICED — DELIVERY TIME APPROX. 6 WEEKS.

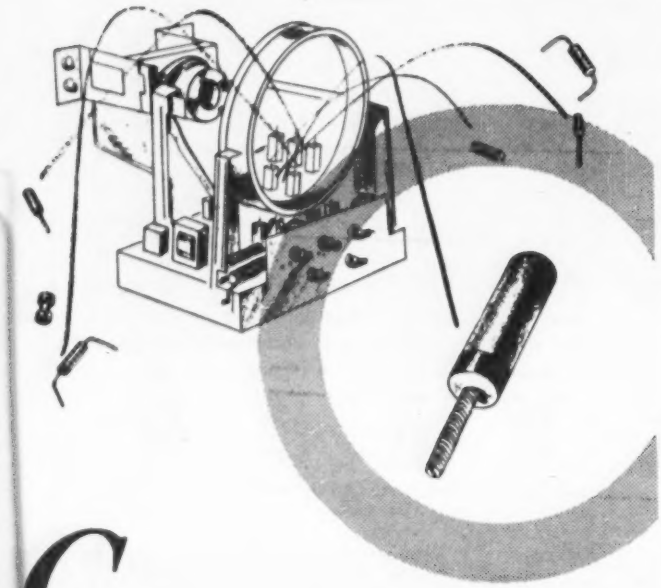
Designers and Manufacturers of Graphic Recorders

SOUND APPARATUS COMPANY STIRLING, N. J.

Instruments Engineered for Individual Requirements

MOLDITE IRON CORES

KEEP THE OWNER OF THIS SET *HAPPY*



CONSISTENT HIGH QUALITY PERFORMANCE ...IS THE ANSWER

HERE'S WHY:

- Our own formulas are used exclusively
- We specialize in making iron cores only
- Our engineers are thoroughly familiar with every iron core application
- Continuous manufacturing controls assure uniformity, quality, economy, dependability
- Special powder mixing equipment and procedures
- Increased production, test, and inspection facilities (Note new address below)

Samples promptly submitted upon request for design, pre-production, and test purposes.

SEND FOR CATALOG 104

NATIONAL MOLDITE COMPANY

1410 CHESTNUT AVENUE HILLSIDE 5, NEW JERSEY

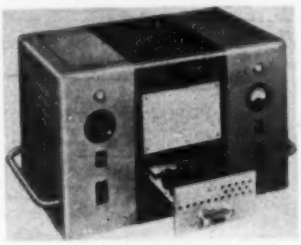
Jerry Golton Co.
2750 W. North Ave., Chicago 22, Ill.

Portmuth-Colman & Associates
1335 South Flower, Los Angeles, Cal.

(Northern N. Y.)
Martin P. Andrews, Garden City, N. Y.

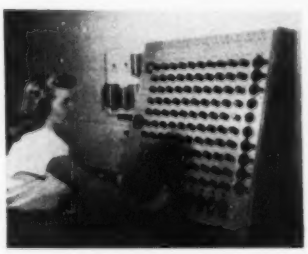
Jose Luis Pontet
Cordoba 1472, Buenos Aires

beam antenna. The stepped-up driven element affords an excellent match to 300-ohm line. If desired, a special T match can be provided for a 72-ohm match. It uses a 1-in. boom and ½-in. element of 61ST duraluminum. For additional gain it may be stacked at a half wave, and a stacking harness is available.



Dielectric Heater

HIGH FREQUENCY HEATING CO., 143 Glen Park Ave., Gary, Ind. The 1.5 AH preform heater is a bench machine for heating plastics, rubbers and other dielectric materials. It will raise the temperature of 1½ lb of average material 170 degrees in one minute. The loading tray is 6 × 8 in. and will accommodate material up to 3 in. high. High-frequency energy is provided at 40 mc.



Electrical Computer

PHILLIPS PETROLEUM CO., SPECIAL PRODUCTS DIVISION, Bartlesville, Oklahoma. Type 66 Spectro electrical computer solves simultaneous linear equations of the type encountered in infrared and mass spectrometry. It uses d-c electrical potentials substituted for the unknowns in the equations and solves the equations by a method of iteration. Results of spectroscopic analy-

keep with it!

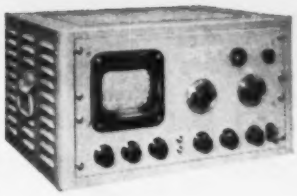
Be sure you get that famous ALTEC 21B quality from over-active announcers and recording artists by using the new 155A Chestplate. Because of the microphone's perfect positioning, you may readily obtain the sound separation you desire from vocalists working with an orchestra... without false bass! With this new adaptation of the 21B, sports announcers can always override even the noisiest crowds, for the 21B does not limit at audio peaks. Its smooth frequency response permits use in high-level sound fields which would ordinarily cause acoustic feedback.

The 155A Chestplate is compact, lightweight and contains a matching unit which permits its use up to 400 feet away from associated equipment.

Send for brochure giving technical information on ALTEC 21B Miniature Microphone adaptations.

ALTEC
LANSING CORPORATION

1161 N. VINE ST., HOLLYWOOD 38, CALIF.
161 SIXTH AVE., NEW YORK 13, NEW YORK



USES

- Ultrasonic Vibration Measurements
- Harmonic Analysis
- Cross Modulation Studies
- Noise Investigations
- Determining Transmission Characteristics of Lines and Filters
- Monitoring Communications Carrier Systems
- Checking Interference, Spurious Modulation, Parasitics, Effects of load changes, shock, humidity, component variations, etc. upon frequency stability
- Telemetering

SPECIFICATIONS

Frequency Range: 2 KC—300KC, stabilized linear scale

Scanning Width: Continuously variable from 200KC to zero

Four Input Voltage Ranges: 0.03V. to 50V. Full scale readings from 1 millivolt to 50 volts

Amplitude Scale: Linear and two decade log

Amplitude Accuracy: Within 1db. Residual harmonics suppressed by at least 50db.

Resolution: Continuously variable. 2KC at maximum scanning width, 500c.p.s. for scanning widths below 8KC.

WRITE NOW For Complete Information, Price and Delivery

Available Now!

Easy, Fast Ultrasonic Spectrum Analysis WITH MODEL SB-7 PANORAMIC ULTRASONIC ANALYZER

An invaluable new direct reading instrument for simplifying ultrasonic investigations, the SB-7 provides continuous high speed panoramic displays of the frequency, amplitude and characteristics of signals between 2KC and 300KC. The SB-7 allows simultaneous observation of many signals within a band up to 200KC wide. Special control features enable selection and highly detailed examination of narrower bands which may contain signals separated by less than 500c.p.s. The instrument is unique in that it provides rapid indications of random changes in energy distribution.

MARION RUGGEDIZED METERS

This amazing new family of Marion ruggedized electrical indicating instruments sets new standards of quality and accuracy in electrical measurement. Marion "Ruggedized" instruments give better performance in *any* application. Use them with confidence even where you never before dared use "delicate instruments." They exceed all JAN-1-6 requirements, are *hermetically sealed* and completely interchangeable with existing JAN 2½" and 3½" types.

Marion Ruggedized instruments perform perfectly under critical conditions of shock, vibration, mechanical stress and strain. Hermetic sealing makes them impervious to weather and climate.

When you want the *best* in meters for any application —from bulldozers to Geiger Counters—insist on Marion, the name that means the most in meters.

Send for our booklet on Marion Ruggedized Instruments. Marion Electrical Instrument Company, 401 Canal Street, Manchester, New Hampshire.

MARION MEANS THE MOST IN METERS

Manufacturers of hermetically sealed meters since 1944

marion meters

Trademark
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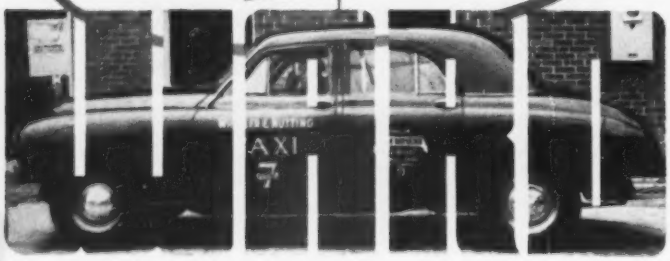
Ward Aerials Give Radio-Equipped Taxicabs the Best Service



● Regardless of the make of transmitter and receiver, Ward aerials assure the best performance on radio equipped taxicabs.

● The Model SPP-18 Roof Top Mount for intercommunication on the 140-165 megacycle band is ruggedly constructed to withstand corrosive atmospheric conditions such as ice, snow, sleet, rain, and fog.

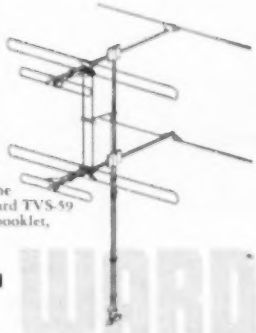
● Equipped with a twelve foot coaxial lead cable, the Ward Model SPP-18 is easily installed *without cutting the car upholstery.*

WARD
World's Finest
Aerials

Ward is the largest and oldest exclusive maker of auto radio and television aerials.

WARD PRODUCTS CORPORATION
1523 E. 45TH STREET • CLEVELAND, OHIO
Division of the Gabriel Company

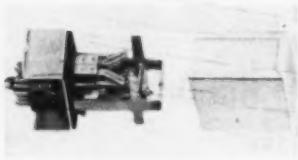
Another chapter in the
"SUCCESS STORY OF THE MAGIC WAND ANTENNAS"



Ward Model TVS-59 was especially designed to provide better reception in fringe areas. Comparative tests with the best competitive antennas of this type prove that the new Ward TVS-59 *outperforms all others on all channels.* Write for our *free* booklet, "The Story of the Magic Wand." It contains interesting, authoritative information about TV and FM antennas.

WARD PRODUCTS CORPORATION
1523 E. 45th STREET, CLEVELAND, OHIO
Division of the Gabriel Company
Ward is World's largest manufacturer of antennas for radio and television

sis of hydrocarbon samples have been computed to an accuracy of 0.1 percent with the instrument. Bulletin 278 gives a detailed description of the unit and its uses.

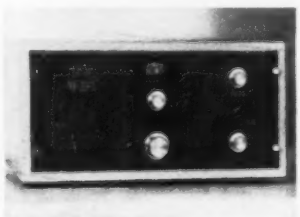


Relay Enclosure

C. P. CLARE & CO., 4719 West Sunnyside Ave., Chicago 30, Ill. Illustrated is the new dust-tight plug-in enclosure for the small type J relay, showing cover removed. Steel cover and Neoprene gasket, through which terminals are closely fitted, effectively occlude dust. Installation is facilitated by use of a standard radio-type plug, which also reduces wiring costs. Full description is given in bulletin 108.

High-Impedance Transformer

AMERICAN TRANSFORMER CO., Newark, N. J. Transformers for use with specific tubes have been designed to limit the inrush and operating currents to the values recommended by tube manufacturers. A table is available showing ratings for individual tube requirements, including data for single or polyphase operation.

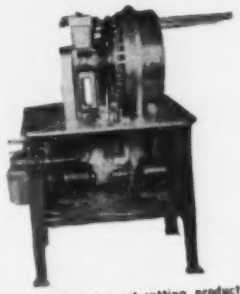


ULF Oscillator

KROHN-HITE INSTRUMENT CO., 580 Massachusetts Avenue, Cambridge 39, Mass. Model 410-A wide-range, ultra-low frequency oscillator com-

Kahle specialists in custom-built, ultra-precision
ELECTRON TUBE MACHINERY

KAHLE CUSTOM-BUILDS machines to make the exact tubes you require—from big 20-inchers to tiny sub-miniature—from laboratory types to those for high-speed production. Kahle puts each unit through exhaustive trial runs in our plant to assure trouble-free operation in yours.



#1507 Automatic Glass Tubing, Cutting Machine

High Speed • Horizontal Type For Soft Glass, Chill Cut

30 head, continuous drive. Dual motor, variable speed. High production on a specific diameter. Length of cut adjustable. 7,500 to 15,000 per hr.

We specialize in cost-cutting production-boosting, labor-saving equipment for complete manufacture of cathode ray tubes, standard, miniature and sub-miniature radio tubes, sub-miniature tubes, fluorescent lamps, photocells, x-ray tubes, glass products.

Consultations invited
Send for our new catalog

Kahle ENGINEERING CO.
1309 Seventh Street, North Bergen, New Jersey

MR. ENGINEER..

TRIAD TRANSFORMERS
will meet and maintain the most exacting requirements of your equipment

AVAILABLE FROM STOCK

Triad "HS" Series Transformers are engineered to meet precisely and maintain indefinitely the most exacting requirements of any industrial electronic application. Maximum protection against failure of your product is assured through:

- Hermetic Sealing
- "Climatite" Treatment (the improved and exclusive vacuum impregnation process used on all Triad transformers)
- Conservative Ratings
- Strong Mechanical Construction
- Exceptional Electrical Characteristics
- Long, trouble-free life

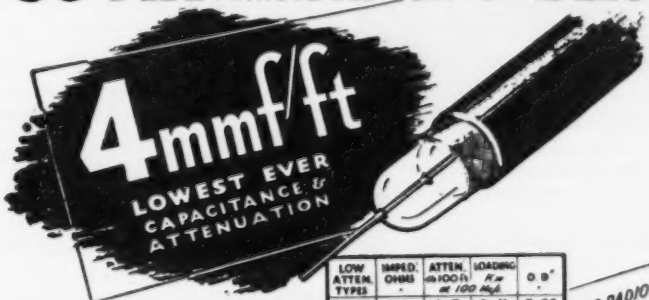
Triad "HS" Series Transformers are carried in stock for immediate delivery by Triad distributors or at the factory. **Write for Catalog TR-49A.**

Also readily available in standard designs for most used circuits are Triad Geoformers (Geophysical Transformers). **Write for Catalog GP-49.**

TRIAD TRANSFORMER MFG. CO
2254 Sepulveda Blvd.
Los Angeles 64, Calif.

CO-AX AIR-SPACED ARTICULATED R.F. CABLES

4mmf/ft
LOWEST EVER CAPACITANCE & ATTENUATION



	LOW ATTEN. TYPES	IMPED. OHMS	ATTEN. db/100 ft at 100 Mc/s	LOADING K at 100 Mc/s	O.D."
HIGH POWER FLEXIBLE	A.1	74	1.7	0.11	0.36
	A.2	74	1.3	0.24	0.44
	A.34	73	0.6	1.5	0.85

FOR RADIO FREQUENCIES

	LOW CAPAC. TYPES	CAPAC. mmf/ft	IMPED. OHMS	ATTEN. db/100 ft. 100 Mc/s	O.D."
PHOTOCELL CABLE	C.1	7.3	150	2.5	0.36
	P.C.1	10.2	132	3.1	0.36
	C.11	6.3	173	3.2	0.36
	C.2	6.3	171	2.15	0.44
	C.22	5.5	184	2.8	0.44
VERY LOW CAPACITANCE CABLES	C.3	5.4	197	1.9	0.84
	C.33	4.8	220	2.4	0.64
	C.44	4.1	252	2.1	1.03

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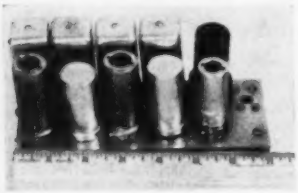
bines the subaudio with the normal audio frequencies and provides both sine and square-wave outputs over the frequency range from 0.02 to 20,000 cps. Six frequency bands are provided, each covering a full decade, with continuous control of frequency. The unit features an ability to recover quickly from bandswitching and similar disturbances. Sine-wave output recovers to 90 percent of steady-state amplitude in less than 2 cycles of the dial frequency.



Frequency Standards and Dividers

ANALYSIS INSTRUMENT CO., P.O. Box 231, East Paterson, N. J., is manufacturing frequency standards incorporating a new type divider. The divider, when used in conjunction with crystal or tuning-fork standard oscillators, makes possible a more compact arrangement for supplying motor drive frequencies for facsimile and similar applications. Illustrated is a complete frequency standard for delivering 60 cycles from a 90.72-kc crystal-controlled oscillator.

Circuit Breaker Attachment

SAFETY DEVICES MFG. CO., 570 7th Ave., New York, N. Y. A new lightweight circuit-breaker attachment designed to convert small snap-action switches into circuit breakers operates over a wide temperature range. Called the Therm U adapter, the device weighing only 0.3 oz may be used to replace circuit breakers in aircraft.

Literature

Pulse Rise Time Indicator. Electronic Systems Co., 555 E. Tremont

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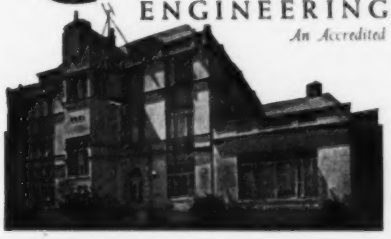

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Ave., New York 57, N. Y. Description, illustration and specifications of the model 632-B pulse rise time indicator are given on a single page. The instrument covered is intended for the accurate plotting of the rise time of rapidly rising positive voltage pulses, employing a specially designed delay line of variable length and a vtvm.

Electrical Contacts. Gibson Electric Co., 8361 Frankstown Ave., Pittsburgh 21, Pa. A line of Steelback electrical contacts consisting of silver facing individually bonded to steel backing for projection welding to contact supports, is illustrated and described in circular 501. Specifications for standard contacts are included.

Nuclear Instrumentation. Kelley-Koett Instrument Division, 20 E. Sixth St., Covington, Ky., is now publishing Kelefax, a new bimonthly publication of interest to personnel engaged in radiation and industrial instrumentation, nuclear science and technology. It contains articles by members of the engineering staff and guest authors, useful reference data and tables, and announcements of new products.

Radiographic Materials. Eastman Kodak Co., X-Ray Division, Rochester 4, N. Y. A new 16-page catalog of materials for industrial radiography describes films for use with x-ray equipment of varying kilovoltage and with specimens of varying thickness and density. Information on relative speeds and contrast of different x-ray film emulsions is provided in a handy chart.

General-Purpose Pulse Generator. Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif. Volume 1, No. 6 of the Journal is a four-page description of the model 212A, a 0.07 to 10-μsec general-purpose pulse generator. Included are specifications and photographs of oscilloscope traces of three typical major output pulses of different duration.

Coaxial Measuring Equipment. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. A

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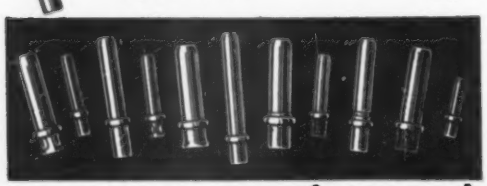

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recent 4-page folder describes and illustrates a line of uhf measuring equipment for college, and research and development laboratories. The components included are designed for measurements on antennas, oscillators, amplifiers, transmitters, receivers and overall systems such as communications, data transmission, remote control and dielectric heating equipment.

Disc Ceramics. Cornell-Dubilier Electric Corp., South Plainfield, N. J. The Tiny Mike line of miniature ceramic disc capacitors is treated in a recent two-page catalog insert. The capacitors treated, used chiefly in tv, f-m and vhf applications, are designed for bypass and coupling in assemblies that are compact and in miniature electronic equipment. The units described are 19/32 in. in diameter and 5/32 in. thick.

Germanium Diodes. General Electric Co., Syracuse, N. Y. A new loose-leaf book entitled "Welded Germanium Diodes" covers every necessary aspect of this component from general sales information to service notes and applications. References to additional information in the literature are included. Price is $1.25.

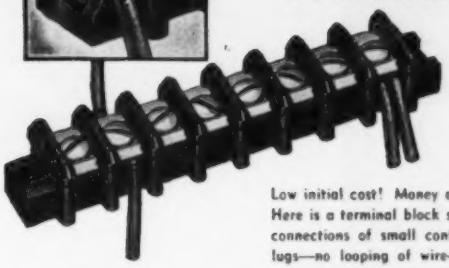
Tube Characteristics. Sylvania Electric Products, Inc., Emporium, Pa. The new radio tube characteristics chart is comprised of 28 pages of technical data. Types are listed in numerical and alphabetical order. Complete instructions on the use of the chart are included.

Power Supplies. Furst Electronics, 12 S. Jefferson St., Chicago 6, Ill. Six types of electronically regulated power supplies are shown in a four-page folder. Information given for each includes maximum output power, output voltage and current, maximum ripple voltage (rms) and size.

Slow-Speed Oscilloscope. A. E. Cawkell, 7 Victory Arcade, The Broadway, Southall, Middlesex, England. Leaflet No. 7 gives a general description, design information and specifications for the type SP10 slow-speed oscillo-

For #18 Stranded
or #16 Solid Wire or Smaller

CURTIS TYPE "E" Terminal Blocks



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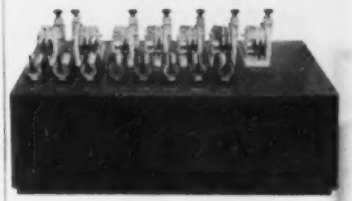

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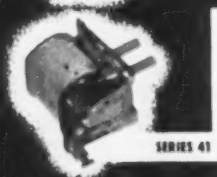

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SERIES 7

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SENSITIVE RELAYS
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scope for use wherever very slow speed waveforms are required to be observed.

Insulating Compound. Dow Corning Corp., Midland, Mich., has published a 16-page booklet on the uses of DC4 silicone compound for waterproofing and insulating aircraft ignition systems and electronic equipment. Many illustrated applications are given.

Time Measuring Instruments. American Chronoscope Corp., 316 W. First St., Mount Vernon, N. Y. A 4-page bulletin illustrates and describes a line of electromechanical chronoscopes, input adapters and photoelectric adapters for measuring significant operating times from 10 μsec to 3 sec.

Electrical Contacts. Fansteel Metallurgical Corp., North Chicago, Ill. A new 36-page illustrated booklet contains information on electrical contacts of value to design engineers. It includes a thorough discussion of contact materials, their properties, advantages and uses. The booklet also contains a glossary of electrical contact engineering terms and a series of captioned illustrations enabling recognition of symptoms of contact failure.

Transformer Bulletin. American Transformer Co., 178 Emmet St., Newark 5, N. J. Bulletin 110-02 describes an improved line of air-cooled (dry-type) transformers. It contains 8 pages of information and data, including tables which list standard ratings with dimensions, weights list prices and wiring diagrams of transformers in capacities up to 200 kva, single-phase, and 300 kva, three-phase.

Airborne Equipment Protection. The Barry Corp., 177 Sidney St., Cambridge 39, Mass. Catalog 502 deals with vibration isolators and mounting bases used to protect electronic equipment and other sensitive apparatus against shock and vibration encountered in aircraft applications. Two pages of the catalog discuss principles involved in shock and vibration control, with special emphasis on the effect of air damping.

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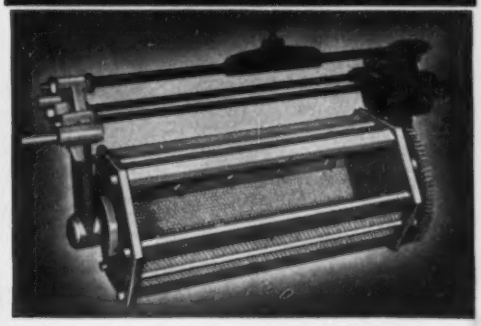

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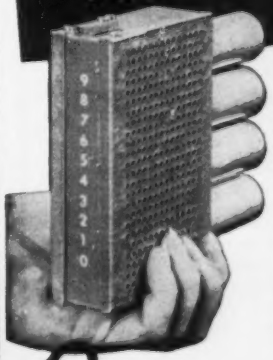
for **ELECTRONIC COUNTING APPLICATIONS**

MODEL 700 *Berkeley* **DECIMAL COUNTING UNIT**



This versatile component is adaptable to a wide range of applications in counting, timing and frequency measurements. It has scale-of-ten direct reading based on a reliable binary circuit. It has easily met power and pulse input requirements and is designed for plug-in operation. It is a self-biased unit, which, although for operation at 300 v., functions consistently at 200 to 450 v. It can be easily built into your apparatus. Combined with these advantages are miniature size and sturdy construction. Price $55.00. Discounts on quantities. Send for Bulletin DCU-114.

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Metal-plastic components designed and manufactured to order. Write for quotations specifying electrical and mechanical characteristics. Describe application. No obligation.

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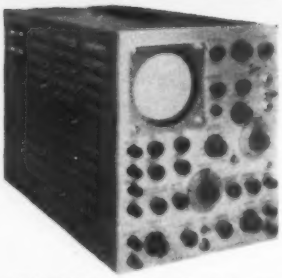

VERSATILE . . . *The* ***Tektronix Type 512*** *Oscilloscope is capable of meeting most requirements in the varied fields of SONAR, RADAR, GEOPHYSICS and BIOPHYSICS. With a vertical amplifier band width of DC to 2 mc and sweep speed range from .3 sec/cm to 3 microsec/cm the observation of either low or high speed phenomena is readily accomplished.*

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NEWS OF THE INDUSTRY

(continued from page 130)

meaning no. Then later the beam can be redirected at the area on which needed information is stored in order to read off the signal it applied earlier.

On the electrical characteristics of the beryllium mosaic, according to the engineers, depend the reliable fast storage and reading which make this tube so promising for high-speed electronic computer applications. The mosaics are made by special equipment in a high-vacuum chamber.

The MIT engineers reported that their new electrostatic storage tube should be useful in any application where high-speed storage of digital coded information is needed.

Future improvements of the tube resulting from work now in progress are expected to decrease access time to 6 to 12 μsec and increase storage density to 1,024 digits.

Thermocouple Tables To Be Revised

Now under way at the National Bureau of Standards is an extensive project for the revision of all the common thermocouple tables. Present plans call for the publication during 1950 of eight tables giving the temperature-emf relations for platinum-platinum rhodium, chromel-alumel, and copper-constantan thermocouples.

The temperature-emf tables for thermocouples previously issued by the Bureau have been widely used in science and industry, not only to convert thermocouple voltages into the equivalent measured temperatures but also in the preparation of purchase specifications for thermocouple wire and in defining the relation between impressed emf and scale reading for pyrometers which indicate temperature directly. Recently, however, in accordance with international agreement, the Bureau adopted the absolute electrical units and began using the definitions of the new International Temperature Scale of 1948 both in its own research program and in calibrating instruments for other laboratories and industries. Revision of the thermocouple tables was then advisable in order to make

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New!

Series 570-600
Pointer-Type
D-C Galvanometer

Here is a new addition to the line of G-M galvanometers. It is a completely assembled unit featuring an Alnico magnet for greater stability of calibration and a new high in sensitivity. Easily installed and replaced; requires only 2¾" below the mounting surface. Rugged construction throughout. Three models, with sensitivities per mm. division of .06, 0.10 and 0.20 microamps.

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Waveflex Waveguides

The WAVEFLEX waveguide incorporates *all* of the advantages of rigid waveguides while offering the additional feature of flexibility. Designers of radar, FM, and television transmission equipment have discovered that this combination of properties simplifies many of their design problems.

WAVEFLEX waveguides offer lower attentuation loss, excellent impedance match, and extreme flexibility without loss of efficiency. They are made in accordance with joint Army-Navy specifications. Let us work with you in developing special waveguides for your special applications.

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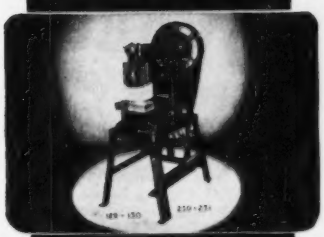

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Power Punch Presses

These efficient presses feature high speed, deep throats, all steel welded frames, inexpensive auxiliary attachments, various punches and dies from stock. They have a 5-ton safety factor.

Throat Depths — 12" and 18"
Capacity — 10 tons

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The New STAVER **MINI-SHIELD**

TRADE MARK REG. AND PAT. PEND.

The shield that fits all Miniature Tubes

A flexible shield that snugly fits all miniature tubes because it compensates for all variations in tube dimensions. Mini-Shields are made for both T5½ and T6½ bulb tubes. Send for catalog sheet.

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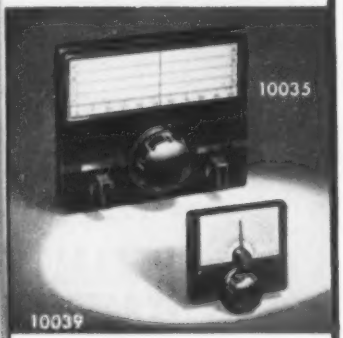

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A pair of truly "Designed for Application" controls. Large panel style dial has 12 to 1 ratio; size, 8½" x 6½". Small No. 10039 has 6 to 1 ratio; size, 4" x 3¼". Both are of compact mechanical design, easy to mount and have totally self-contained mechanism, thus eliminating back of panel interference. Provision for mounting and marking auxiliary controls, such as switches, potentiometers, etc., provided on the No. 10035. Standard finish, either size, flat black art metal.

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them consistent with former usage.

In the preparation of the tables, emphasis is being placed on convenience for use. Thus, explanatory text will be short, numerals will be as large as practical, and layout of pages and headings will be arranged to facilitate interpolation. The argument will be presented at one-tenth the interval given in the original tables. Inverse tables, formerly lacking, will also be included. Each table, together with its inverse, will be issued as an NBS Miscellaneous Publication and, when announced, will be available from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Prior to publication, inquiries should be addressed to Pyrometry Laboratory, National Bureau of Standards, Washington 25, D. C.

BUSINESS NEWS

POLARAD ELECTRONICS CORP., manufacturers of television broadcast equipment, test equipment and microwave systems, have moved to larger quarters with increased facilities for production and development at 100 Metropolitan Ave., Brooklyn, N. Y.

HOFFMAN RADIO CORP., Los Angeles, Calif., has added 20,000 sq ft of floor space to its local plants through the purchase of property on South Grand Ave., adjacent to the rear of its plant No. 3.

THE AMERICAN GAGE & MACHINE CO. has merged with the Simpson Electric Co., Chicago, Ill., manufacturer of electrical measuring instruments and radio and television test equipment.

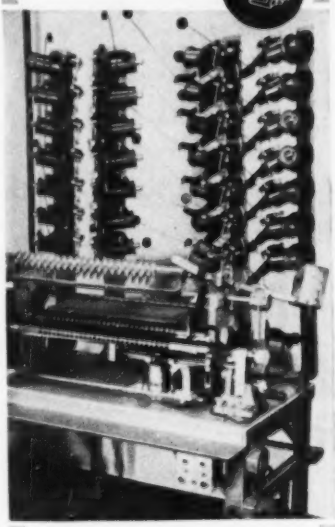
INSULINE CORP. OF AMERICA has acquired 10,000 sq ft of additional factory space in Long Island City, N. Y., for the manufacture of television antennas and accessories.

RADIO ENGINEERING LABORATORIES have consolidated operations into their main plant at 36-40 37th St., Long Island City, N. Y.

REEVES SOUNDCRAFT CORP., manufacturers of transcription record-

WIND more COILS faster

WITH YOUR PRESENT COIL-WINDING MACHINE!



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Installation of these inexpensive PAMARCO tensions lowers winding costs because each machine will accommodate more coils at higher winding speeds. In addition to increased production, PAMARCO tensions raise production quality. Free-running action practically eliminates wire breakage and shorted turns. Simple thumb screw setting quickly adjusts for any wire gauge. No tools or special skill are needed for operation. For complete data call or write.

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The Green Engraver offers great speed and convenience. Quickly cuts up to four lines of letters from 3/64" to 1" on curved or flat surfaces whether made of metal, plastics or wood . . . operates by merely tracing master copy—*anyone* can do an expert job. Special attachments and engineering service available for production work. Just the thing for radio, electronic apparatus and instrument manufacturers.

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● Dials ● Lenses ● Molds ● Instruments

. . . also does routing, profiling and three dimensional modeling.

**Price does not include master type and special work holding fixtures.*

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AUTOMATIC OSCILLOGRAPH *Recorder*

Developed for simplicity and ease of operation, the HEILAND Automatic Oscillograph Recorder saves time . . . reduces costs. Flexibility of operation permits the recording of strain, vibration, pressure, acceleration and temperatures.

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E = Breakdown voltage
e = Rated d.c. working voltage

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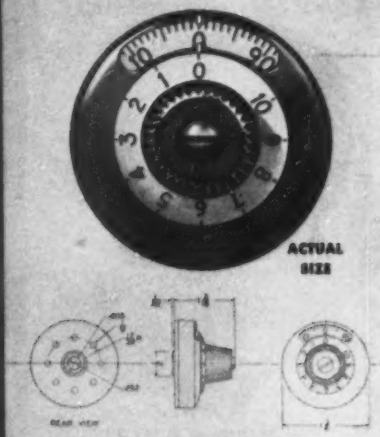
TEN TURN-COUNTING DIAL

Microdial is composed of two concentrically mounted dials . . . one for counting increments of each turn and the other for counting turns. The incremental dial has 100 equal divisions and is attached rigidly to the shaft so there is no backlash. Thus the contact position is indicated to an indexed accuracy of 1 part in 1000. Rotation is continuous in either direction. There are no stops on the Microdial assembly.

COMPACT . . . Microdial has same O.D. as Micropot . . . requires no more panel space.

CLEAR READING . . . Forced fast-reading tests showed only 1/20th as many errors with Microdial open window as with next most legible dial. Turn counter distinguishes between 0 and 10 turn readings, and accelerates to avoid confusion on readings near integral turns. Precise readings are made from larger dial with maximum separation of graduations and wide angle visibility.

CONVENIENT . . . delivered completely assembled with dials synchronized. Easily mounted in a few seconds. All dials may be locked.



Microdial . . . turn-counting dial, primarily designed for use on Micropot ten turn linear potentiometer . . . use it on any multiturn device having ten turns or less.

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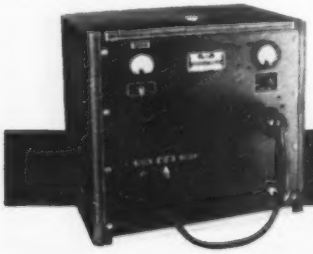
THE GEORGE W. BORG CORPORATION
DELAVAN · WISCONSIN

"IT'S THE BEST YET!"

Yes! We think it's the best yet. We think this transmitter ideal for such applications as Police, Forestry, Airport Traffic Control, Oil Fields, Aerophare, Beacons, Explorations, Public Utilities, Mining, Emergencies and Point-to-Point requirements. It can be controlled either locally or from remote position; either for telephone (A-3) or telegraph (A-1 or A-2) service . . . it is compact, complete and designed for hard service.

This transmitter is crystal controlled. Single channel with plug-in coils for bands 200-525 kc and 1.6-13.5 mc; dual channel with self contained coils for the band 2.5-13.5 mc. Carrier power output 25 watts A-1 and 50 watts A-3. Types of tubes used, 807 and 866A (or 1B25 for low temperatures). Suitable for use in either tropical or cold climates. With the addition of tone oscillator the single channel unit becomes a 50 watt beacon (Aerophare) transmitter, and is used in conjunction with AK-3 identification keyer and ATU-75SE antenna tuner. Operates from either 115 or 230 volts, 50/60 cycles.



Model 50HXS

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ing blanks and sapphire needles, recently began to manufacture and sell magnetic recording tape.

RADIO CORP. OF AMERICA recently held dedication ceremonies for its new Marion, Indiana, television picture tube plant. The ceremony

Small forest of electron guns moves along production line at RCA's new Marion, Ind., plant

marked the installation of basic machinery and conveyor-belt systems which will eventually make the plant one of the biggest mass-producers of tv picture tubes.

ACME ELECTRIC CO., Cuba, N. Y., has begun construction of a new 15,000-sq ft-floor-area building adjacent to its plant No. 1 to increase production of tv transformers.

ELECTRICAL REACTANCE CORP., ceramic capacitor manufacturer, will double its present capacity with the establishment by August 1 of a new $400,000 plant at Olean, N. Y.

ALLEN B. DUMONT LABORATORIES, INC., recently opened its 175,000-sq ft Allwood plant in Clifton, N. J., to be devoted exclusively to c-r tube production.

PERSONNEL

CHARLES M. SCHEDLBAUER, formerly chief engineer of Electronic Associates, Inc., Long Branch, N. J., is now the company's director of sales.

FRANK GOLDSTEIN, a member of the engineering staff of radio station

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1. You get permanent accuracy because the resistance wire is locked in place. It is precision positioned and moulded integrally with the housing.
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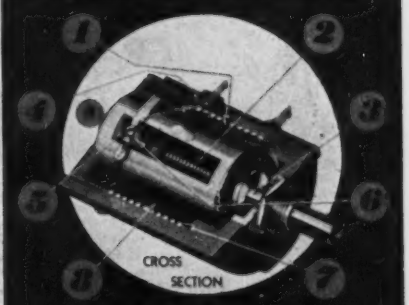
3. You get precise positioning of the moving contact because of the two bearings supporting the rotor assembly.
4. You get good rigid terminals because they are moulded integrally with the housing.
5. Terminals soldered to ends of resistance element before moulding. Entire resistance circuit is an integral part of the housing.
6. You get accurate setting and re-setting due to anti-backlash spring in contact guide.
7. You get a fine resolution because of the 43½" length of resistance wire in the spiral element.
8. You get a resistance output directly proportional to shaft rotation within ±0.1% of the total resistance. Every potentiometer is automatically machine tested for linearity at 101 points.



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Units for immediate shipment:
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Special resistance values made to order.

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• STABLE • DEPENDABLE • MODERATELY PRICED •

- **INPUT:** 105 to 125 VAC. 50-60 cy
- **OUTPUT #1:** 200 to 325 Volts DC at 100 ma regulated
- **OUTPUT #2:** 6.3 Volts AC CT at 3A unregulated
- **RIPPLE OUTPUT:** Less than 10 millivolts rms

WIDTH 14" DEPTH 6" HEIGHT 8" WT. 17 LBS.

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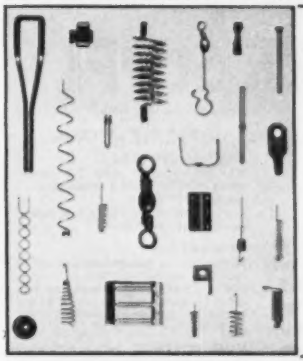

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TOP PERFORMANCE—LOW COST

Laboratories—Industry—TV—Broadcasters

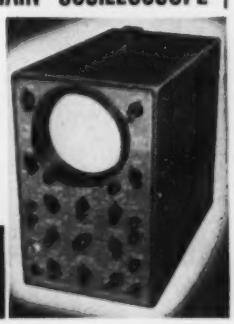
AT LAST! an engineer's scope built by engineers for highest standards of quality and performance. Compare these specifications:

★ Y-AXIS: Sens. 10 mv rms/in; Good transient response,—3 db at 10 MC; L.F.—10% tilt at 10 cps.

★ SWEEPS: 10 cps to 50 KC; recurrent and driven, expansion 5x full scale—writes 1 μsec/in.

★ Internal Calibrator and 60 cy phase shifted sweep. Uses 5UP1 CRT— ±Sync Amplifier.

Only $279.50. *Write for full data to Dept. A-601*



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...REAL SPACE-SAVER!

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MULTI-DECK TAP SWITCH
Series 5000

NEW—*Beautifully compact.* Accommodates 1 to 10 decks. Diameter 1-3/32". Behind panel dimension for one deck, 13/16". Complete 360° rotation possible, clockwise or counter-clockwise. Rated to break 1 amp at 115 volts AC. Carries 5 amps at 115 volts AC. Either *Shorting* Type (make before break) or *Non-Shorting* Type (break before make).

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MODEL 204A REGULATED POWER SUPPLY

0-500 VOLTS D.C. AT 300 MA. WITH POSITIVE OR NEGATIVE GROUND

The Model 204A Regulated Power Supply will provide from 0-500 volts of well regulated and well filtered D.C. The output voltage is continuously variable without switching and either positive or negative side may be grounded.

SPECIFICATIONS:

OUTPUT VOLTAGE
High Voltage: 0-500 Volts D.C. continuously variable (Without switching).
Current: 300 Ma.
Low A.C. Voltage: 6.3 Volts A.C. at 6 amps. center-tapped, unregulated.

REGULATION
Within 1% for voltage between 30-500 volts, from no load to full load.
Within 1% for line voltage variations from 105 to 125 volts at full load current for any voltage between 30-500 volts and within 2% at 10 volts.

HUM VOLTAGE
Within 10 Millivolts at any voltage or load within ratings.

LINE INPUT
105-125 Volts A.C. 50-60 cycles.

OUTPUT TERMINATIONS
High and low voltage outputs available from front and rear of unit. Positive or negative terminal of high voltage output may be grounded as desired.

Detailed specifications will be forwarded upon request without obligation.

E/M

ELECTRONIC MEASUREMENTS COMPANY
RED BANK • NEW JERSEY

WMOR, Chicago, during the past year, was recently appointed chief engineer of that station.

CURTIS B. PLUMMER has been promoted from chief of the television broadcast division of the FCC's Bureau of Engineering to chief engineer in charge of the new Office of Chief Engineer.

C. B. Plummer

D. McDonald

DONALD MCDONALD, formerly with the Aeronautical Research Center, U. of Michigan, has been appointed director of the Signal Laboratories section of the Cook Research Laboratories, Chicago, Ill.

EDWARD B. DOLL, formerly chief engineer at North American Philips Co., has joined the engineering staff of Stanford Research Institute, Stanford, Calif.

JOSEPH H. COPP, previously associated with General Electric Co. as audio and television systems engineer, has been appointed audio facilities engineer for the American Broadcasting Co.

LEWIS P. TABOR, senior research engineer in the Franklin Institute Laboratories for Research and Development, has been elected chairman of the Institute's Science and Arts Committee.

EDMUND C. ALTENBERGER, formerly with Essex Electronics, has joined Fugle-Miller Laboratories, Metuchen, N. J., as chief engineer responsible for the design of new television coil assemblies.

LAVERNE M. POAST has joined the firm of Craven, Lohnes and Culver, consulting radio engineers at Washington, D. C., as a new partner.

GERALD C. SCHUTZ, formerly chief of the radar techniques unit at Air Materiel Command, has been appointed chief electronics engineer

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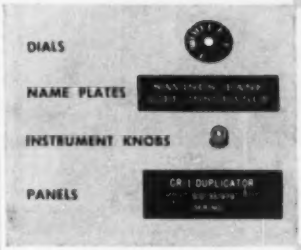

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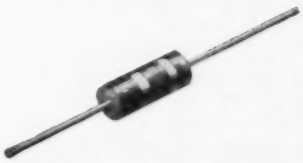

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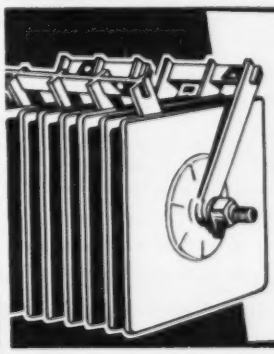

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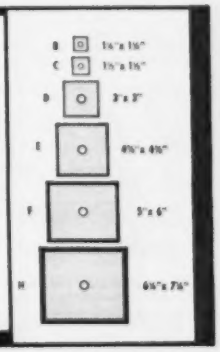

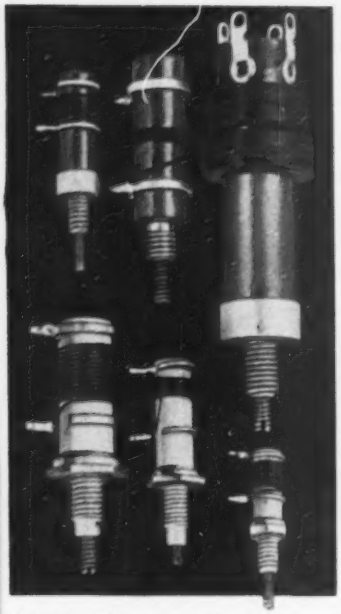

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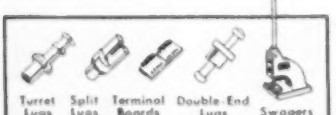
Coil Form	Material	Mounting Stud Thread Size	Form O.D.	Mounted O.A. Height
L51	L-5 Ceramic	8-32	⅝"	1⅝"
L56	L-5 Ceramic	10-32*	¾"	1⅞"
L53	L-5 Ceramic	¼-28*	¾"	1⅞"
L5M	Paper Phenolic	8-32	¾"	1⅝"
L52	Paper Phenolic	¼-28	¾"	1⅞"
L54	Paper Phenolic	¼-28	⅞"	2"

*These types only provided with spring locks for slugs. †Fixed lugs. All others have adjustable ring terminals. All ceramic forms are silicone impregnated. Mounting studs of all forms are cadmium plated.



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JOHN A. WILLOUGHBY, former acting chief engineer of the FCC, has been appointed assistant chief engineer in the new Office of Chief Engineer.

JOSHUA SIEGER, director of research and development at Freed Radio Corp., New York, since 1948, was recently promoted to vice-president in charge of engineering.

J. Sieger

R. Bowen

JOHN A. RANKIN, chief engineer at Hoffman Radio Corp., Los Angeles, Calif., for the past nine months, has become vice-president in charge of engineering.

DALE POLLACK, consulting radio engineer, announces the removal of his laboratory and office to his new building on Dayton Road, Waterford, Conn.

JOSEPH P. STEPHANILE, formerly engaged in technical and engineering work with Government installations, is now associate electronics engineer at Telrex, Inc., Asbury Park, N. J.

ALBERT W. HULL, inventor of the magnetron, recently retired as assistant director of the General Electric Research Laboratory, Schenectady, N. Y., but will continue to serve the laboratory as a consultant.

JOHN M. PEARCE, former head of the electronics section of The Glenn L. Martin Co., has been named chief electronics engineer and head of the new electronics department in the company's engineering division.

JOBE JENKINS, formerly electronics group engineer, is now in charge of the systems development and analysis units of the electronics department at The Glenn L. Martin Co.

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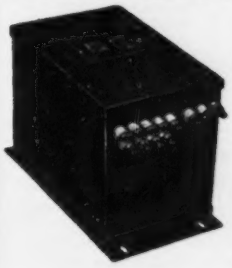

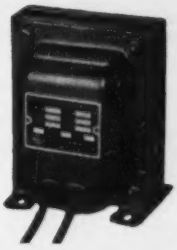

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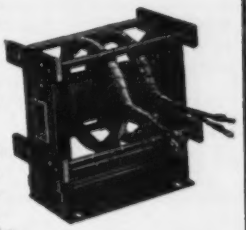

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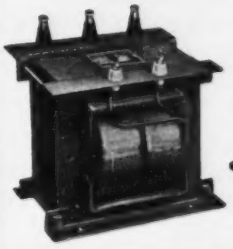

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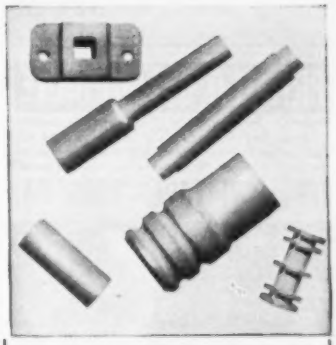

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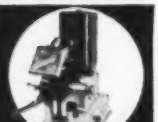

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veloped by Mr. John Ruze of this laboratory, states that the power gain will be slightly less than the value given by

$$G = \frac{27{,}000}{\beta_h \beta_v}$$

where G is the power gain of the array over that of a half-wave dipole, and β_h and β_v are half-power beamwidths expressed in degrees in the horizontal and vertical planes, respectively.

Using this formula and the beamwidths as given in Table III of the article, the power gain of the various arrays (with a dipole for a transmitting antenna) over that of a pair of dipoles is as follows:

Array No.	1	2	3	4	5
Power Gain	18	33	77	84	105
Gain in Db	12.5	15.2	18.9	19.2	20.2

The system power gain will be increased by 6.0 decibels in each case if the single-turn circular antenna is substituted for the transmitting dipole.

In general, the gain of any practical antenna cannot be increased indefinitely without running into the grave obstacles encountered in the design of super-gain systems.

WALTER ROTMAN
Antenna Laboratory
A. F. Cambridge Res. Labs.
Cambridge, Mass.

Paralleled Thyratrons

DEAR SIRS:

THE SHORT NOTE entitled, "Operating Small Thyratrons in Parallel", which appeared on page 202 of your March issue was read with much interest. The technique disclosed was developed during the war for parallel operation of thyratrons such as the 2050 and 2D21 for modulation of low and medium-power radar transmitters.

Resistances, inductances, and center-tapped coils have been successfully used in the cathode circuits with cross connections to the shield grids. This work was undertaken by the undersigned at the RCA Laboratories and is referred to in U. S. Patent 2,481,925, Sept. 13, 1949, and By H. H. Wittenberg in the March 1949 *RCA Review*.

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NEW ADVERTISEMENTS received by May 2nd will appear in the June issue, subject to limitation of space available.

The publisher cannot accept advertising in the Searchlight Section which lists the names of the manufacturers of resistors, capacitors, rheostats, and potentiometers or other names designed to describe such products.

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U. S. Government

Notice to Contractors

GENERAL SERVICES ADMINISTRATION
Community Facilities Service
Washington 25, D. C.

Sealed proposals will be received by Rufe B. Newman, Jr., Director, Public Works Construction Division, Community Facilities Service, General Services Administration, Room 5143, General Services Building, Washington, D. C., until 11:00 o'clock A.M., Eastern Standard Time, on May 24, 1950, for the construction of telephone and radio link facilities and buildings on the islands of St. Thomas and St. Croix (U. S. Virgin Islands) as follows:

PROJECT No. 55-113, ST. THOMAS TELEPHONE SYSTEM
(Project No. 13, Public Law 510, 78th Congress)
Subproject 13A—Outside Telephone Plant, St. Thomas
Subproject 13B—Inside Telephone Plant, Charlotte Amalie
Subproject 13C—Subscriber Telephone Plant, St. Thomas
Subproject 13R—Radio Link Stations, Virgin Islands
Subproject 13X—Telephone Exchange, Charlotte Amalie

PROJECT No. 55-509, ST. CROIX TELEPHONE SYSTEM
(Project No. 26, Public Law 510, 78th Congress)
Subproject 26A—Outside Telephone Plant, St. Croix
Subproject 26B—Inside Telephone Plant, Christiansted and Frederiksted
Subproject 26C—Subscriber Telephone Plant, St. Croix
Subproject 26X—Telephone Exchanges, Christiansted and Frederiksted,

at which time and place the proposals will be publicly opened and read aloud. Bids received after closing time of bid opening will be returned unopened.

Plans and specifications and other proposed contract documents are open for public inspection at the District Engineer's Office, Charlotte Amalie, St. Thomas, U. S. Virgin Islands; the District Engineer's Office, 501 Banco Popular Building, San Juan, Puerto Rico and Room 5130, General Services Building, Washington, D. C. A set of such documents may be procured from any of the above-listed offices upon deposit of $50.00, all of which will be returned to bona-fide bidders upon the return of plans and specifications, in good condition, within seven days of date of bid opening.

Each proposal must be accompanied by a bid security in an amount not less than 5 percent of the total bid.

Bids will be accepted on any single subproject or project.

The successful bidder(s) will be required to furnish performance bond(s) in an amount equal to 100 percent of his (their) bid(s) and payment bond(s) in an amount equal to 100 percent of his (their) bid(s); such bonds to cover full performance of the contract(s) and payment(s) for labor and materials.

No proposal may be withdrawn after the scheduled closing time for receipt of bids for at least 30 days.

The Government reserves the right to reject any and all proposals and to waive informalities with respect thereto.

PERE F. SEWARD,
Commissioner
(100)

Desirable positions at a New England Manufacturing plant specializing in Micro-wave Electron Tube Development and Manufacture.

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P-6252, Electronics
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TR-ATR Duplexer Section for above . . 8.50
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SE	Shipboard	10 CM,	Compl.	New	1200
SF-1	Shipboard	10 CM,	Compl.	New	2800
SJ-1	Submarine	10 CM,	Compl.	Used	1500
SL-1	Shipboard	10 CM,	Compl.	Used	1700
SN	Portable	10 CM,	Compl.	Used	600
SO	Portable	10 CM,	Compl.	Used	650
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SO-8	Shipboard	10 CM,	Compl.	Used	1500
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Mark 10	Guntaying	10 CM,	Compl.	New	2000
			Less Rack	New	1500
			Less Rack	Used	1100
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CPN-8	Beacon	10 CM,	Complete	New	2000
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200 MC COAXIAL PLUMBING

Right Angle Bend . . $35.00
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3 cm. wavemeter, Ordnance type micrometer head now: Absorption type . . $85.00
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10CM ECHO BOX CABV 14ABA-1 of OBU-3, 2890 MC to 3170 MCS direct reading micrometer head Ring prediction scale plus 9% to minus 9%. Type "N" input. Resonance indicator meter. New and Comp. w/access. Box and 10CM Directional Coupler . . $350.00
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10 cm Wavemeter. WE type B 435490 Transmission type. Type N Fittings. Veeder Root Micrometer dial. Gold Plated W/Calib. Chart P/o Freq. Meter X66404A. New . . $89.50

K BAND

APS-34 Rotating Joint . . $49.50
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Slotted line, Demornay-Budd #397, new . . $450.00
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DBM ANTENNA. Dual, back-to-back parabolas with dipoles. Freq. coverage 1,000-4,500 mc. No drive mechanism $65.00

ASI25/APR Cone type receiving antenna. 1080 to 3208 megacycles. New $4.50

140-600 MC. CONE type antenna, complete with 25 sectional steel mast, guys, cables, carrying case, etc. New $49.50

ASD 3 cm. antenna, used, ex. cond $49.50

YAGI ANTENNA AS-46A, APG-4, 5 elements. $14.50
Dish for Parabola 30" $4.85

ASI7/APS 10 CM Antenna, APS-2 30 Inch Dish with ⅞ Coax Dipole and Fittings. New and Compl. with 24 V DC Drive motor, selsyn. 360 Deg. Rotation and Vertical Tilt $94.50

RC-224 Antenna, 10 CM, 30" Dish P/O. SCR-717 Radar, New and Complete $94.50

R. F. EQUIPMENT

LHTR, LIGHTHOUSE ASSEMBLY. Part of RT-39/APQ 5 & APG 15. Receiver and Trans Cavities w/ assoc. Tr. Cavity and Type N CPLG. To Rcvr. Uses 2040, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver plated $49.50

APS-2 10CM RF HEAD COMPLETE WITH HARD TUBE (715B). Pulser, 714 Magnetron 417A Mixer all ⅞" rigid coax. incl. rcvr. front end $210.00

Beacon lighthouse cavity 10 cm with miniature 28 volt DC FM motor. Mtg. Bernard Rice ..... $47.50 ea.

T-128-/APN-19 10 cm. radar Beacon transmitter package. Used, less tubes ..... $59.50 ea.

Pre-Amplifier cavities type "M" 741059GL, to use 446A lighthouse tube. Completely tunable. Heavy silver plated construction ..... $37.50 ea.

RT/32APS 6A RF HEAD. Compl. with 725A Magnetron magnet pulse xfmr. TRA-ATR 721 A/B local osc. and beacon mount, pre amplifier. Used but Good cond. $97.50

AN/APS-15A "X" Band compl. RF head and mod. incl. 725-A mag and magnet, two 723A/B klystrons (local osc. & beacon) 1B24, TR, rcvr and ampl. duplexer, HV supply blower, pulse xfmr. Peak Pwr Out: 45 KW apx. input 115, 400 cy. Modulator pulse duration .3-.2 microsec. apx. 13KV. Pk. Pulse, with all tubes incl. 715B, 829B, BKR 23, two 72's. Complete pkg. $350.00

S BAND AN/APS2. Complete RF head and modulator, including magnetron and magnet, 417A mixer, TR receiver duplexer, blower, etc., and complete pulser. With tubes, used, fair condition $75.00

ASB-500 Megacycles Radar Receiver with two GL 446 lighthouse cavities, new less tubes $37.50

10 CM Rec Assy. Less Local OSC. Tube. Consists of mixer stabilizer cavity 30 MC preamp AFC, Inc. Amp. plugs & cables p/o APS2 ..... $37.50

#SCR-520 RF Head Compl. with Hard Tube Pulser c/o 2 Aluminum Drums MTD.
In Tandem, Compl. W/Tubes $350.00

Mark 4 Radar Console (FD) Compl "L" Band RF Pkg. c/o Magnetron CSC, Pulser, Rcvr, H.V. Power Supply. Complete $850.00
115 V. 60 cy. operation.

INDICATORS—SCOPES

BC 9318 420-50-100 mile range 5" scope w/mtg. rack, indicator amplifier, BC 932B, visor, New w/ tubes $24.50

BC 204A 9-36-90 mile range 5" scope $17.50

BC 937A & BC 938A 12" PPI & "A" scope. Complete desk Rack assy w/osc. control unit, rec., pwr. supls. in unused cond. but shelf worn $300.00

Radar indicator RW #81 mfg. by Research Enterprise Ltd. 5" scope $30.00

PRECISION CAPACITORS

D-163707: 0.4 mfd @ 1500-vdc. —60 to plus 85 deg C $4.50
D-163815: .01 mfd @ 600 vdc. 0 to plus 65 deg C $2.00
D-170698: 0.152 mfd, 300 v, 400 cy, —40 to plus 85 deg C $2.50
D-164960: 2.04 mfd @ 200 vdc. 0 to plus 55 deg C $2.50
D-160544: 2.16 mfd @ 200 vdc. 0 to plus 55 deg C $3.00
D-161555: .5 mfd @ 400 vdc. —60 to plus 85 deg C $3.00
D-161270: 1 mfd @ 200 vdc, temp comp —40 to plus 65 deg C $12.50

30 US ARMY SIGNAL CORPS RADIO MASTS

Complete set for erection of a full flat top antenna. Of rugged plymold construction telescoping into 3 ten-foot sections for easy stowage and transportation. A perfect set-up for getting out. Supplied complete: 2 complete masts, hardware, shipping crate. Shipping wt. approx. 300 lbs. Big Corps #2A289-233-A. New ..... $39.50 per set

YD-2 MARKER BEACON EQUIP. Compl. Installation in Trailer w/Gas Generator—WHITE.

MAGNETRONS

Ask for Qty. Price

Tube	Frq. Range	Pk. Pwr. Output	Price
2J27	2965-2992 mc.	275 KW.	$8.50
2J31	2930-2960 mc.	265 KW.	$25.00
2J21 A	9345-9405 mc.	50 KW.	$25.00
2J22	3257-3333 mc.	285 KW.	$25.00
2J26	2992-3019 mc.	275 KW.	$25.00
2J27	2965-2992 mc.	275 KW.	$8.50
2J32	2790-2820 mc.	285 KW.	$35.00
2J37			$45.00
2J38 Pkg.	3249-3263 mc.	8 KW.	$35.00
2J39 Pkg.	3267-3333 mc.	67 KW.	$35.00
2J40	9305-9325 mc.	10 KW.	$60.00
2J49	9000-9160 mc.	58 KW.	$85.00
2J34			$55.00
2J61	3000-3100 mc.	38 KW.	$45.00
2J62	2914-3010 mc.	35 KW.	$65.00
3J31	24,000 mc.	80 KW.	$55.00
5J30			$30.50
714AY			$25.00
718DY	2720-2980 mc.	250 KW.	$25.00
720BY	2900 mc.	1000 KW.	$50.00
720CY	2860 mc.	1000 KW.	$50.00
725-A	9345-9405 mc.	80 KW	$25.00
730-A	9345-9405 mc.	60 KW.	$25.00
726 AY, BY, CY, DY, EY, FY, GY			$50.00
700 A, B, C, D			$50.00
706 AY, BY, DY, EY, FY, GY			$50.00
Klystrons. 723A/B $12.50; 707B W/Cavity			$20.00
417A $25.00	2K41		$65.00

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4850	¾ in.	⅝ in.	$12.50
5200	¾ in.	⅝ in.	$17.50
1300	1¼ in.	1⅛ in.	$12.50
1860	1½ in.	1½ in.	$14.50

Electromagnets for magnetrons ..... $24.50 ea.
GE Magnets type M7765118, GI Distance Between pole faces variable. 2⅛"(1900 Gauss) to 1½"(2200 Gauss)
Pole Dia. 1½" New Part of SCR 584 ..... $34.50

"CW" MAGNETRONS

QK 62	3150-3375 mc
QK 59	2675-2900 mc
QK 61	2875-3200 mc
QK 60	2800-3025 mc
New, Guaranteed	Each $65.00
QK 815 Raytheon	$150.00

FILAMENT TRANSFORMER
for above 115V/60 cy Pri; four 6.3V 4A Sec. 5000DVT $27.50
Magnetron Kit of four QK's 2675-3375 inc. w/transformer $250.00

PULSE EQUIPMENT

MIT MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: .001 max. pulse duration: 3, 1.0, 2.0 microsec. Input voltage: 115v, 400 to 2400 cps. Uses 1-715B, 4-829-B, 3-72's, 1-73. New w/Tubes $110.00

APQ-13 PULSE MODULATION. Pulse Width .5 to 1.J Micro Sec. Rep. rate 624 to 1348 Pps. Pk pwr. out 35 KW Energy 0.018 Joules $49.00

TPS-3 PULSE MODULATOR. Pk power 50 amp, 24 KW (1200 KW pk); pulse rate 200 PPS 1.5 microsec. pulse line impedance 50 ohms. Circuit series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes $49.50

APS-10 MODULATOR DECK. Complete, less tubes $75.00

APS-10 Low voltage power supply less tubes $18.50

BC 1201B Loran pulse modulator $129.00

BC 758A Pulse modulator $395.00

725A magnetron pulse transformers ..... $18.50 ea.

PULSE TRANSFORMERS

G.E.K.-2745 ..... $39.50

G.E.K.-2744-A. 11.5 KV High Voltage. 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or ½ microsec. @ 600 PPS. $39.50

W.E. #D166173 Hi-Volt input transformer. W.E. Impedance ratio 50 ohms to 900 ohms. Freq range: 10 kc to 2 mc. 2 sections parallel connected, potted in oil $34.00

W.E. KB 9000 input transformer. Winding ratio between terminals 3-5 and 1-2 is 1.1:1, and between terminals 6-7 and 1-2 is 2:1. Frequency range: 380-520 c.p.s. Permalloy core $8.00

G.E. #K2731 Repetition Rate: 656 PPS. Pri. Imp: 50 Ohms Sec. Imp: 480 Ohms. Pulse Width: 1 Microsec. Pri. Input: 9.5 KV Pk. Sec. Output: 28 KV PK. Peak Output: 800 KW. Rifar 2.75 Amp. $64.50

W.E. #D166271 Hi Volt input pulse Transformer. $27.50

G.E. K245CA. Will receive 13KV, 4 micro-second pulse on pri., secondary delivers 14KV. Peak power out 100KW G.E. $34.50

G.E. #K2748A, Pulse input, line to magnetron. $36.00

#9262 Utah Pulse or Blocking Oscillator XFMR Freq. limits 790-810 cy-3 windings turns ratio 1:1:1 Dimensions 1 13/16 x 1⅝" 19/32 ..... $1.50

Pulse 131-AWP L-421435 ..... $6.00

Pulse 134-BW-2F L-440895 ..... $2.25

RAY—WX4296F $39.50

G.E.—K6024730 ..... $50.00

G.E.—K9216943 ..... $50.00

PULSE NETWORKS

15A—1-400-50: 15 KV, "A" CKT, 1 microsec. 400 PPS, 50 ohms imp. $42.50

G.E. #9E3-5-2000-50P2T, 6KV, "E" circuit, 3 sections, .5 microsecond, 2000 PPS, 50 ohms impedance $8.50

G.E. #3E (3-84-810; 6-2-24-400) 50PAT; 3KV, "E" CKT Dual Unit: Unit 1, 3 Sections, .84 Microsec. 810 PPS, 50 ohms imp.: Unit 2, 8 Sections, 2.24 microsec. 405 PPS, 50 ohms imp. $6.50

7.5E3-1-200-67P 7.5 KV, "E" Circuit, 1 microsec. 200 PPS, 67 ohms impedance, 3 sections $7.50

7.5E4-10-60-67P 7.5 KV, "E" circuit, 4 sections, 10 microsec. 60 PPS, 67 ohms impedance $15.00

7.5E3-3-200-6PT, 7.5 KV, "E" Circuit, 3 microsec. 200 PPS, 67 ohms imp., 3 sections $12.50

DELAY LINES

D-163169 Delay Line Small quantity available. $50.00
D-168184: .5 microsec. up to 2000 PPS, 1000 ohms term. $4.00
D-170499: .25/.50/.75 microsec. 8 KV, 50 ohms imp. $16.50
D-165907: 1½ microsec. $7.50

SONAR

QCU Magneto striction head RCA type CR 278225—New $95.00

Stainless Steel streamlining housings for above $18.50

QBG Driver Amplifier. New $200.00

QCU Magneto striction head, coil plate assembly, new $14.50

QCQ-2/QCS Magneto striction head coil plate assembly $14.50

QCQ2 Sonar complete set—Write for details.

QC-RCA magneto striction head assy. consists of coil, plate, nickle diaphragm plate, milled steel body unassembled $5.00

Supersonic Oscillator RCA 17-27 Kc. Rec. Driver, Csc, 115 v 60 cy. AC. Designed for use w/200 watt driver. New less tubes $39.50

WEA-1 Console. Consists of Rec. Ind. Osc. Remote training control 200 watt driver amp. 17-27 kc range $450.00

QCQ 2 Console Sub. Sig. Co. $450.00

QBF Sonar mfg. WE complete console consists of 10-40 kc rec. driver osc. ind. & control unit, and driver amplifier 22-28 kc. Write

QJA Sonar QBF w/QJA adaptor kits w/cathode ray tube indication. Write

QCQ-2 Sonar Compl. Less Hoist—Write

I.F.F. 1 KW Pulsed Output Pkg. Tunable 154-174 mc. adj. modulating pulses 4-10 micro sec. comp. 115v 50cy ac pwr. supply.
Video output receiver. New w/tubes $350.00
Wavemeter for above $75.00
Dipole Array for above $65.00
BC 800 XMTR, RCVR, Unit New $55.00
BC 929 Indicator New $35.00

PULSE EQUIPMENT

All merch. guar. Mail orders promptly filled. All prices, F.O.B. N.Y.C. Send M.O. or Chk. Only shipping chgs. sent C.O.D. Rated Concerns send P.O.

COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y. Dept. E-5 P. J. PLISHNER **Phone: Digby 9-4124**

COMMUNICATIONS EQUIPMENT COMPANY

RELAYS

Contacts	Rating	Coil Ohms	Mfg.	Price
DPDT	24-28V	170	GEC R2791B	75c
(SA)	vdc		100F3	
8PDT	28vdc	175	GEC R2791B	75c
4PDT	24-28vdc	175	GEC R2791B	75c
4PST	24vdc	180	GEC R2791G	75c
DPDT,	12 vdc	44	Leach 1067-	1.25
SPST			6967	
DPDT	22-28 vdc	160	Leach	1.25
8PST	28 vdc	250	Allied BO48	.75
DPDT	14 vdc	55	Price X20-A	.65
8PDT	24-28 vdc	280	Allied 100X-3	1.50
8PST	24-28 vdc	2400	GM 12917-1	.75c
DPDT	24vdc	280	Allied BO535	1.00
3PDT	26vdc	280	Allied K8	1.10
(10A)			5910	
DPDT	28 vdc	280	Allied BO	1.00
			61585	
8PST	75MA	60	Allied K8	.85
(NC)			5863	
DPDT	20-30 vdc		Ounce 50XB	1.00
DPDT	10-14 vdc	Ounce	100AB	1.00
DPDT	24-28 vdc		PB21C057-A	1.00
DPDT	24-28 vdc		GECR2791	1.50
8PDT	24-28 vdc		GECR2791	1.00
DPDT	12 vdc		Ounce	1.49
4PDT	10-12v	125	Ounce	1.49
DPDT	27.5 vdc	400	Allied	1.10
DPDT	9-14 vdc		Allied	1.10
DPDT	24v60cy	50	Allied	1.40

MANY OTHERS—WRITE YOUR NEEDS

ARC 3 MINIATURE RELAYS

Can 8PDT 8 Prong GEC R2791C104 1.95
8PDT, 28 vdc 300 RBM45542 .85c
8PST, 22-28 vdc 300 RBM5528 .85c
8PST, 22-28 vdc 300 RPM55251 .85c
DPDT, 22-28 vdc 300 RBM35531 .85c
DPST
8PDT, 22-28 vdc 300 RBM5526 .85c

H. V. MICAS
SEND FOR LISTS OF OTHERS

Fig.	Mfd.	Voltage	Price	2 For
D	.01	1200WVDC	$0.50	$0.95
E	.00025	2500TVDC	.29	.55
E	.00004	2500WVDC	.39	.75
E	.000047	2500WVDC	.39	.75
E	.01	500WVDC	.25	.45
C	.002	3000WVDC	1.05	2.00
C	.01	2000WVDC	1.50	2.90
C	.00003	2000WVDC	.49	.95
C	.00039	3000WVDC	.75	1.45
C	.00082	3000WVDC	1.00	1.95
C	.002	3000WVDC	1.00	1.05
C	.005	5000WVDC	1.65	3.25
C	.0004	6000WVDC	1.50	2.95
C	.0006	3000WVDC	1.00	1.95
C	.0008	3000WVDC	.95	1.85
E	.0016	3000WVDC	.65	1.25
E	.000080	3000WVDC	.40	.75
B	.08	1500VDC	10.00	19.00
B	.03	2000VDC	12.00	23.00
B	.045	2000VDC	12.00	23.00
B	.00015	20000VDC	24.00	47.00
B	.0001	20000VDC	24.00	47.00
B	.0012	20000VDC	24.00	47.00
B	.006	2500VDC	1.45	2.85
E	.00027	2500WVDC	.35	.65

LAMPS

Tung Sol #1448 14v 10 ..... 60c
Manla #62; 24-28v 10 ..... 60c
Tung Sol #1251 24-28v 10 ..... 80c
G.E. #1.M37 13v 10 ..... 80c
Manla 10w 60v Red ..... 10c ea.
Tung Sol 6A P 51, 6 8v ..... 15c ea.

WIRE WOUND POTS

20,000 ohms, 10%, 8 watt, $ .95
5,000 ohms, 10%, 7 watt, 5.95
15,000 ohms, 10%, 4 watt, 5.95
Dual 250 ohms, 25 watt, 5.98
50 ohms, 25 watt, 5.98
1000 ohms, 50 watt, mod J 5.98
300 ohms, 50 watt mod J 5.98
5 ohms, 250 watt, mod L $2.95

INVERTERS

PE 218-E: Input: 25 28 vdc, 80 amp. Output: 115 v, 350-500 cy 1500 volt amperes. Dim: 17"x8¾"x10" Now $29.50
Now (as shown)
PE 218-H: Same as above except size 15"x 6" x 10" Now $29.50
PE 218H, used, good cond. $22.00
PE 203: Input: 28 vdc, 28 amps. Output: 80 v, 500 cy, 500 volt amps. Dim: 17" x 5¾" x 10¾" Now $12.50
GE 5021N13A: Input: 28 vdc, 25 amp. Output: 115 v, 400 cy, 485 volt amps. Dim: 9" x 5¾" diam. Now $49.95

STAND OFFS

w/alum base 1 1/4x8" $1.25
w/alum base 1"x6" 95c
w/alum base 1 1/4x5" 95c
w/alum base 1x4" 79c
w/alum base 1 3/4x3 3/8 1.69
w/alum base 1 5/8x3" 1.00
1N84 sp1, 2 1/4" 10c
1N81 feed support 1 1/2" 8c
1N82 feed support 3" 16c
stand off 3"x1"-6 20c
stand off 6 3/4x1"-6 40c
spreader 2 1 8x5 8 8c 8c
spreader 2 11 16x7 16"-6 10c
Thru panel 1 1 4x3 4d 15c
Pow/thru s53, 6 3 4x3"-6 1.10
Antenna IN86 15c

Ceramicons

Mmt

1	25
3	27
3.1	35
4	30
5	47
6	50
7	57
8.5	58
11	60
15	62
20	67
24	70
30	220
115	240
125	250
150	350
180	1000
200	

Feed Button Thru

40	100	50
150	200	500
175	500	470
185		

COAX CABLE

RG 8/U, 52 ohm
RG 9/U, 52 ohms ..... $.25/Ft.
RG 57/U, Twin Cond. 95 ohms
..... $.35/Ft.
RG 23/U, twin coax, 125 ohm imp. armored ..... $.50/Ft.
RG 28/U, 50 ohm imp. pulse cable
Corona min. starting voltage 12 KV
..... $.50/Ft.
RG 35/U, 70 ohm imp. armored
..... $.50/Ft.
Many other Cables & Wire in stock. Write

MAE WEST XMTTR

New w/wire tubes etc. ..... $3.49 ea.
733 Localizer Receiver $6.95

ARC-5 Equip Avail. Write for list of Parts and Equip.

SCR 522 VHF Xmtr Rcvr. 100-156 MC w/tubes $34.95
KS 9486, H.F. 60-15000 CPS 250 Watt Audio 5000 ohm PTT 9 ohm V.C. $10.95

Birtcher Tube Clamps

926C
926-16
926-B1
926-B2
926-B8
926-C-15
926-C-18 926-B31
926B 926C-23
926-C-19 929-1
926B-16 926B-10
926A-14 926B-18
926A 926-K2
926C1 10 $1.40
926A11 Each 15c 100 $12.00

MOUNTINGS

MT-5/ARR2	FT-225A
MT-7/ARR2	FT-229A
MT-171A/U	FT-232A
FT-265A	FT-234A
FT-340	MT-85/ARC5
MT-167/U	MT-78/ARC5
FT-308A	MT-62/ARC5
FT-282A	
MT-80/ARC5	
FT-141	

VIBRATORS

TR 1210, 12 vdc, 5 pin $1.00
OAK V-6875, 24-32 vdc, 7 pin $1.00
Mal. Type G534C, 12 vdc, 5 pin $1.00
Mal. Type G629-C, 12 vdc, 4 pin $1.00
Mfrs. quantities in all types available.

RF CHOKES

1Mhy/125MA .25
1.9-2Mehy .10
2.5Mhy/500Ma .10
3.2Mehy .10
3.3Mehy .10
3.6Mehy .10
5.2Mhy/200Ma .10
5.5Mhy/500MA .98
6.4Mehy .10
10Mhy/350Ma .39
20Mehy .10
94Mhy .10
100Mehy .10
115Mhy/150Ma .39
185Mehy .10
220Mehy .18

AUDIO

UTC OUNCER PL to MULTI grids, 10K to 2-125K ohms Sec. $1.49
OUNCER PL TO LINE
Pri. 7K to 250 ohms Sec. Price 49c
PL to V.C., 7500 to 3½ ohms Sec. 79c
OUNCER PL TO H.S. or Line 10K to 4K ohms. Tapped at 250 ohms 69c
PL to HS, 14,200 ohms to 8000 ohms 98c
LINE TO GRID, 600 to 50K ohms. Price $1.10
PL TO LINE, 8K to 250 ohms. Price $1.00
MIKE OR LINE TO GRID, 100 to 50K ohms. Tapped at 100 ohms. Price $1.10
U.T.C. I.T RATIO 500 ohms, 3db ÷ 1db, 50 to 8000 cy Ounce 98c
MANY OTHERS

WHOLESALE ONLY

Phone or Write for Quantity & Price
Digby 9-4124
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1,000,000 Bathtubs
4,000,000 Micas
300,000 Sil. Micas
100,000 Oil Cond.
4,000,000 Resistors
400,000 Electrolytics
400,000 H. V. Micas
100,000 K. V. Cond.
150,000 Prec. Resis.
500,000 Tube Clamps
1,000,000 An. Connectors
50,000 Dynamotors
20,000 Power Xfrmrs
20,000 Chokes
100,000 Audios
50,000 Audio Xfrmrs
100,000 400 Cy Xfrmrs
100,000 Shock Mts.
25,000 Magnetrons
5,000 Magnets
50,000 Pulse Xfrmrs
50,000 Control Boxes
500,000 Tubes
300,000 Relays
500,000 Pots
35,000 Vibrators
200,000 UG Connectors
2,000 Scopes
1,500 Asst. Phones
20,000 Headsets
5,000 Mikes
100,000 Elements
Tons of Nuts & Bolts
Screws, Etc.
1,000 Gibson Girls
500 BC 375
Complete
500,000 Insulators
150,000 Binding Posts
200,000 Wafer Switches
300,000 Ceramicons
500,000 Ferrule Resis.
50,000 PL 54
25,000 JK 26

R-5/ARN7

Receiver w/ Tubes New $39.50
Control Box $3.95

COMMAND SET

Heineman Ckt. Bkrs. for AC 18° Operation Amperes .010, 1, 7, 50, 80, 100, 120. Ea. $1.10
Kilson 25A, 5A .75c

CONNECTORS 80% OFF LIST

3102	14S	2P-A-S	3106	18	4S
3102	16S	3P	3106	18	11S
3102	18	1S	3106	18	1S
3102	18	3P	3106	22	10S
3102	18	4P	3106	24	7P
3102	20	1P	3106	28	1P
3102	20	4P-A-S	3106	28	2P-A-S
3102	22	17S	3106	28	4S
3106	28	2S	3106	28	12P
3106	10S	4S	3108	16S	1P
3106	12	5S	3108	16S	4P
3106	14S	2P-A-S	3108	20	7S
3106	14S	5P-A-S	3108	20	11S
3106	15	3S	3108	20	17P
3106	14S	6S	3108	22	6P
3106	12S	3P	3108	22	8S

500,000 DIFFERENT TYPES IN STOCK

BATHTUB CAPACITORS

Fig.	Mfd.	Voltage	Terminal	Price
D	3 x .1	600VDC	3	33c
E	3 x .1	400VDC	3	33c
C	.1	400VDC	2	20c
C	2 x .1	600VDC	3	29c
E	.025	600VDC	2	18c
A	.2	400VDC	2	48c
C	.1	600VDC	2	25c
E	2 x .25	600VDC	3	29c
A	.5	1000VDC	2	45c
D	.1	600VDC	2	25c
E	3 x .1	600VDC	3	38c
E	.5	200VDC	2	20c
C	.05	600VDC	2	21c
E	.5	600VDC	2	25c
C	.5	1200VDC	2	18c
E	.1	600VDC	2	20c
E	.4	50VDC	2	25c
C	.1	400VDC	1	25c
E	.1	1000VDC	2	30c
C	3 x .1	600VDC	3	33c
E	2 x .25	400VDC	3	27c
D	.5	600VDC	2	25c
D	2 x .1	600VDC	3	29c
D	.5	600VDC	1	20c
E	2 x .1	200VDC	2	20c
C	.5	400VDC	1	28c
	.1	100VDC	2	15c
A	.02	1500VDC	2	45c
C	.5	600VDC	2	25c
C	.5	200VDC	2	20c
E	20-20	50VDC	2	25c

UPRIGHT OIL CAPACITORS
STANDARD BRANDS

Fig.	Mfd.	Voltage	Terminals	Price
B	1	600VDC	2	35c
E	.25	400VDC	2	39c
E	.5	600VDC	2	35c
E	.1	600VDC	2	39c
D	2 x .5	600VDC	3	49c
D	3 x .1	600VDC	3	55c
B	.25	400VDC	2	35c
D	.5	600VDC	2	35c
B	.5	600VDC	2	35c
E	.1	400VDC	2	35c
B	.1	400VDC	2	40c
B	.4	600VDC	2	39c
D	.1	600VDC	2	45c
D	2 x .1	600VDC	2	50c
E	1.75	400VDC	2	35c
D	3 x .1	600VDC	3	55c
A	2 x .5	600VDC	3	49c
B	.1	600VDC	2	45c
B	.1	600VDC	2	45c
D	.1	500VDC	2	45c
A	.1	500VDC	2	45c
B	.1	600VDC	2	45c

EE65E Telephone Test Set

To locate any kind of trouble on Tel lines, can be used as telephone. Includes ringing circuit etc. A valuable unit $18.95

EE89A Telephone Repeater

Used to extend range of field telephones. Simplex Twisg. and 20 cycle ringing possible over lines equipped with unit. Supplied w 3Q5 tube. Phone supplied Weatherweight $9.75

Loading Coil C114

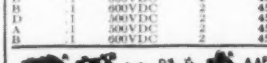
Same as WE No. 633 but in waterproof case to counter balance cap. in line gives clearer signal. Arms used W150 A W130 wire 85c ea.

TIME DELAY RELAY

VACUUM 45 Sec. 117v 60 cy Metal Tube 4 Prong. Edison Price $1.95

GE Relay Herm. Sealed CR2791 5 prong 5 Amp Cont. SPDT $1.25

2 KVA: 30 150v input 50-60 cycles, output 115v 2 kva type RH American $7.99



OIL FILLED CONDENSERS

1—.1 MFD	7000 VDC	$3.27, 2 for	$6.50
.1 MFD	6000 VDC	2.60, 2 for	5.00
.5 MFD	1000 VDC	57c, 2 for	1.05
.5 MFD	2000 VDC	$1.15, 2 for	2.25
2x.5 MFD	1000 VDC	95c, 2 for	1.80
1 MFD	1500 VDC	95c, 2 for	1.80
2 MFD	1000 VDC	87c, 2 for	1.30
4 MFD	1000 VDC	87c, 2 for	1.70
6 MFD	600 VDC	65c, 2 for	1.25
7 MFD	800 VDC	95c, 2 for	1.80
10 MFD	1000 VDC	$1.75, 2 for	2.50
15 MFD	1000 VDC	$2.25, 2 for	4.50

WRITE FOR LIST OF MANY OTHERS
INCL. HIGH VOLTAGE

SHOCK MOUNTS

D	Lord	#1	1 1.4x1 1.4x3/8H 10c
D	Lord	#6	1 1.4x1 1.4x3 8H 10c
D	Lord	#8	1 1.4x1 1.4x3 8H 10c
B	Lord	#15	1 3.4x1 3.4x5 8H 15c
B	Lord	#12	1 3.4x1 3.4x9-16H 15c
B	Lord	#35	2 1.4x2 1.4x1"H 18c
G	U. S.	#5150-C	2 3 8x2 3 8x1 1 8H 35c
F	Lord	#4	2 3 32x1 2 3 32x1"H 35c
C	Lord	#1	1 11 16x1 11 16x3/4"H 14c
C	Lord	#10	2 3 8x2 3 8x1 1 16H 25c
C	Lord	#8	2 3 8x2 3 8x1 1 16H 20c
H	Lord	#5	3x3x1 1 2H 45c
H	Lord	#20	3x3x1 5x8H 39c
H	Lord	#25	3x3x1 5 8H 45c
H	Mearitte	#55	3x3x1 5x8H 49c
H	Lord	#15	3x3x1 1 2H 35c
H	Lord	#45	3x3x1 1 2H 49c
A	Barry	#C2070	3x3x1 1 2H 55c
A	Barry	#C2060	3x3x1 1 2H 55c
A	Barry	#C2090H	3"x3"x1 1 2H 55c

Shaft 6 1 8"1.x3 8" Dia. Thread both sides with nuts, washer, and two woven leads ..... ea. 35c
WRITE FOR TYPES NEEDED

All merch. guar. Mail orders promptly filled. All prices F.O.B. N. Y. C. Send M.O. or Chk. Only shipping chgs. sent C.O.D. Rated Concerns send P.O.

COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y. Dept. E-5 MR. CHAS. ROSEN **Phone: Digby 9-4124**

AIRCRAFT METERS

ALL AIRCRAFT METERS listed are 2½" Square flush type, 6 hole mounting with Black Scales unless noted otherwise.

0-20 Volt D.C. General Electric ..... @ $4.50
0-30 Volt D.C. Westinghouse AX-53 ..... @ $4.50
0-30 Volt D.C. Triplett Mfrd. 2½" R.M with an adjustable extra pointer to show range to be maintained A.C. Type B-1 ..... @ $4.00
40 Volt A.C. Weston 517, 2½" R.M., 3 hole mounting calibrated for 400 cycles ..... @ $3.50
40 Volt A.C. Westinghouse NA-33, 2½" R.M., 3 hole mounting calibrated for 400 cycles ..... @ $3.50
40 Volt A.C. Westinghouse NA-33, 2½" R.M., 3 hole mounting adjusted for operation on 60 cycles ..... @ $3.95
0-30 Amp D.C. Westinghouse AX-33 (USNC-30) with external shunt ..... @ $5.00
30-0-30 Amp D.C. Weston 606, with internal shunt ..... @ $5.00
30-0-100 Amp D.C. Hickok, 2½" R, 3 hole mounting, with external shunt ..... @ $5.50
0-120 Amp D.C. Westinghouse AX-53, with external shunt ..... @ $5.50
120-0-120 Amp D.C. Westinghouse AX-33 with external shunt ..... @ $5.50
0-240 Amp D.C. Sutton-Harsley (British) with external shunt ..... @ $5.50
0-240 Amp D.C. Westinghouse AX-33 with external shunt ..... @ $6.50
240-0-240 Amp D.C. General Electric with external shunt ..... @ $6.50
0-300 Amp D.C. Westinghouse, E-1, 3½" R.M. with external shunt ..... @ $7.50
0-480 Amp D.C. Westinghouse AX-33 with external shunt ..... @ $8.50
30 Volt 60 Amp D.C. General Electric, AN connector type, with connector, with external shunt, push button for volts ..... @ $5.50
30 Volt 120 Amp D.C. Westinghouse AX-33 with external shunt, push button for volts ..... @ $6.00
30 Volt 120 Amp D.C. General Electric, AN connector type, with connector, with external shunt, push button for volts ..... @ $6.00
30 Volt, 240 Amp D.C. Westinghouse AX-33 with external shunt, push button for volts ..... @ $7.50

A.C. VOLTMETERS

15 Volts, General Electric AO-22, 3½" R.B. black scale, MR35B015ACVV ..... @ $3.00
15 Volt, Weston 476, 3½" R.B. ..... @ $4.50
15 Volt, Westinghouse NA-35, 3½" R.B. MR35015 ACVV ..... @ $4.95
15 Volts, AC-DC, General Electric AW-41, 2½" R.B. black scale, Signal Corps IS-122 ..... @ $2.50
15 Volts AC-DC, General Electric AW-41, 2½" R.B. black scale with markings and calibration at 5, 10, & 15 only, Signal Corps IS-122 ..... @ $2.00
15 Volt General Electric AW-41, 2½" R.B. black scale, red mark at 10 volt, calibrated for 800 cycle ..... @ $3.00
40 Volt Westinghouse NA-33, 2½" R.M. black scale luminous markings designed for aircraft 400 cycle, but calibrated for 60 cycles ..... @ $3.95
40 Volt Westinghouse NA-33, 2½" R.M. black scale, luminous markings, calibrated for 400 cycles ..... @ $3.50
40 Volt Weston 517, 2½" R.M. black scale, luminous markings, calibrated for 400 cycles ..... @ $3.50
75 Volt Weston 517, 2" R.M. ring clamp type mounting ..... @ $2.95
150 Volt Weston 317, 2½" R.B. MR35150 ACVV ..... @ $4.50
150 Volt General Electric AO-22, 3" S.B. ..... @ $5.50
150 Volt Triplett 332-JP, 3½" R.M. ..... @ $4.00
150 Volt Triplett 332-JP, 3½" R.B. ..... @ $4.50
150-300 Volt DUAL RANGE Triplett 331-JP, 3½" R.B. with external resistor for 300 volts, scale calibrated 150, double scale indication for 300 volt use ..... @ $5.50
300 Volt Triplett 232 C, 2½" R.M. ..... @ $6.00
300 Volt Burlington 22A, 2½" R.M. ..... @ $6.00

A.C. AMMETERS

10 Amp. General Electric AO-25, 3" S.B. expanded between 4 & 7 amps. Scale calibrated 100 Amps. for direct reading divide scale reading by 10 ..... @ $4.95
30 Amp. Triplett 332-JP, 3½" R.M. ..... @ $3.50
30 Amp. Triplett, 331-JP, 3½" R.B. ..... @ $4.00
60-120 Amp. DUAL RANGE Burlington 32XC, 3½" R.B. with external current transformer ..... @ $7.50
150 Amp. MULTRANGE, General Electric AO-22, 3½" R.B. 5 Amp movement with external current transformer. Complete with simple circuit diagram illustrating how to use this combination to make a multirange A.C. Ammeter containing any or all of the following ranges—5, 15, 30, 50, 75, & 150. Your cost only $7.50

R.F. AMMETERS

All units are complete with internal thermocouple unless indicated otherwise.
500 Milliampere, Weston 425, 3½" R.B with external thermocouple ..... @ $12.50
1 Amp. General Electric DW-44, 2½" R.B. black scale ..... @ $2.95
1 Amp. General Electric DW-44, 2½" R.B. ..... @ $3.50
1 Amp. General Electric DO-44, 3½" R.B. ..... @ $11.50
1 Amp. Weston 425, 3½" R.B. ..... @ $11.50
1.5 Amp. Westinghouse RT-35, 3" S.B. ..... @ $5.50
1.5 Amp. General Electric DO-44, 3½" R.B. ..... @ $5.50
1.5 Amp. General Electric DW-32, 2½" R.M. black scale ..... @ $2.95
2 Amp. Westinghouse NT-35, 3½" R.B. with external thermocouple ..... @ $6.50
2 Amp. Westinghouse RT-35, 3" S.B. ..... @ $5.50
2 Amp. Simpson 135, 2½" R.B. ..... @ $3.50
2 Amp. Weston 425, 3½" R.B. ..... @ $8.50
2.5 Amp. Meclintock MD5601, 2½" R.B. Signal Corps IS-111 ..... @ $4.50
2.5 Amp. Simpson 35, 3½" R.B. ..... @ $4.95
2.5 Amp. Weston 425, 3½" R.B. ..... @ $8.50
2.5 Amp. Westinghouse NT-35, 3½" R.B. ..... @ $5.50
3 Amp. Weston 507, 2½" R.B. black scale ..... @ $3.95
3 Amp. Weston 425, 3½" R.B. with external thermocouple ..... @ $9.50
3 Amp. Westinghouse NT-35, 3½" R.B. MR35W003 RFAA ..... @ $5.50
5 Amp. Westinghouse, RT-35, 3" S.B. ..... @ $7.50
5 Amp. General Electric DO-44, 3½" R.B. ..... @ $7.50
5 Amp. General Electric DO-44, 3½" R.B. with external thermocouple ..... @ $8.50
6 Amp. General Electric DW-44, 2½" R.B. black case ..... @ $2.50
8 Amp. Westinghouse RT-35, 3" S.B. ..... @ $7.50
8 Amp. General Electric DW-44, 2½" R.B. black scale ..... @ $2.95

D.C. MICROAMMETERS

0-100 Microamps. Weston 301, 3" S.B. ..... @ $14.50
0-200 Microamps. Weston 506, 2" S.B. ..... @ $5.50
0-200 Microamps. Westinghouse NX-35, 3½" R.B. MR35W200DCUA approximately 220 ohms, 45 M.V. ..... @ $8.50
0-200 Microampere, Superior 6" x 4¾" flush bakelite case, approximately 500 ohms resistance. Special scale calibrated in ohms, Caption, Insulation Tester ..... @ $7.50
0-400 Microampere movement, Welch 2½" Switchboard meter, round metal case. With internal resistor & scale calibrated for 40 volts D.C. ..... @ $17.50
0-500 Microampere movement, General Electric DO-53, 3" R.B. Special scale with caption "Channel" with paper V.O.M.A. scale ..... @ $4.50
0-500 Microampere movement, General Electric DO-41, 2½" R.B. scale calibrated 0-20 kilosoft D.C. With paper V.O.M.A. scale ..... @ $6.95
0-500 Microampere movement, General Electric DO-53, 3" R.B. scale calibrated 0-15 K.V., with paper V.O.M.A. scale ..... @ $4.95
0-500 Microampere, Dedur Amsco 210, 2½" R.B. ..... @ $3.00
0-500 Microampere, Simpson 125, 2½" R.B. ..... @ $3.50

D.C. MILLIAMMETERS

0-1 M.A. Weston 301, 2½" R.B. ..... @ $7.50
0-1 M.A. Westinghouse NX-35, 3½" R.B. MR35W001 DCMA ..... @ $7.50
0-1 M.A. Westinghouse NX-35, 2½" R.B. special black scale calibrated 200 MA, PA, Plate, & Grid ..... @ $3.00
0-1 M.A. DeJur Amsco, 3½" R.B. scale calibrated 0-4 KV. with paper V.O.M.A. scale and parts list, circuit diagram for making a V.O.M.A. ..... @ $4.50
0-2 M.A. Westinghouse NX-35, 2½" R.B. MR35W002 DCMA ..... @ $5.50
0-3 M.A. Weston 506, 2½" R.B. ..... @ $3.95
0-3 M.A. Gruen GW-280, 2½" R.B. scale calibrated 30, 450 MA and 2000 volts ..... @ $3.50
0-3 M.A. Simpson 126, 2½" R.B. MR35W003DCMA ..... @ $3.95
0-5 M.A. Simpson, 2" S.B. with red mark at 3 volts ..... @ $3.50
0-5 M.A. Westinghouse RX-33, 2" S.B. with red mark at 2 volts ..... @ $3.50
5-0-5 M.A. Western Electric, 2½" round concentric style meter. Scale calibrated 50-0-50 with red marks at 18 MA and 115 volts ..... @ $3.00
0-15 M.A. Simpson 26, 3½" R.B. MR35W015DCMA ..... @ $4.95
0-20 M.A. General Electric DO-53, 3" S.B. ..... @ $3.75
0-20 M.A. Westinghouse NX-35, 3½" R.B. MR35W 020DCMA ..... @ 4.95
0-50 M.A. General Electric DO-41, 3½" R.B. ..... @ $3.50
0-50 M.A. General Electric DO-41, 3½" R.B. ..... @ $4.00
0-50 M.A. General Electric DO-41, 3½" R.B. ..... @ $3.75
0-150 M.A. Gruen 506, 2½" R.B. ..... @ $3.00
0-200 M.A. Gruen GW-511, 2½" R.B. MR35W200 DCMA ..... @ $3.00
0-200 M.A. General Electric DO-41, 3½" R.B. ..... @ $4.50
0-200 M.A. Simpson 26, 3½" R.B. MR35W200DCMA ..... @ $4.95
0-200 M.A. Marion, 3½" R.B. ..... @ $3.50
200-0-200 M.A. General Electric DO-40, 2" R.B. ring clamp mounted, 3hon flanged case ..... @ $3.00
0-500 M.A. Westinghouse NX-35, 2½" R.B. ..... @ $3.95
0-500 M.A. DeJur Amsco 312, 2" S.B. ..... @ $4.50
0-500 M.A. DeJur Amsco, 2½" R.B. ..... @ $4.50
0-500 M.A. General Electric DO-41, 3½" R.B. ..... @ $4.50
0-1000 M.A. DeJur Amsco, 3½" R.B. ..... @ $4.50

D.C. VOLTMETERS

0-5 Westinghouse NX-33, 2½" R.B. 200 ohms per volt ..... @ $3.50
0-30 DeJur Amsco 210, 2½" R.B. ..... @ $3.50
0-30 Triplett M 1231, 3½" R.B. black scale, with pointer set, A.C. type B-1 ..... @ $4.00
0-40 Sun 2AF597, 3½" R.B. 100 ohms per volt ..... @ $4.95
0-150 General Electric DW-41, 2½" R.B. ..... @ $3.95
0-150 Simpson 25, 3½" R.M. ..... @ $6.00
0-150 Weston 301, 3" R.M. 200 ohms per volt ..... @ $4.50
0-150 Weston 301, 3½" R.B. 200 ohms per volt ..... @ $5.50

D.C. KILOVOLTMETERS

All meters are 1000 ohms per volt complete with external precision, wire wound, non-inductive, hermetically sealed ferrule type multipliers JAN type MAF with mounting hardware, unless specified otherwise.

0-1 K.V. Weston 301, 3" S.B. or 3½" R.B. ..... @ $9.50
0-1.5 K.V. Weston 301, 3" S.B. or 3½" R.B. ..... @ $9.50
0-1.5 K.V. Westinghouse NX-35, 3½" R.B. ..... @ $7.50
0-2 K.V. Weston 301, 3" S.B. or 3½" R.B. ..... @ $10.50
0-3 K.V. Weston 301, 3" S.B. or 3½" R.B. ..... @ $11.50
0-3.5 K.V. Weston 301, 3" S.B. or 3½" R.B. ..... @ $11.50
0-4 K.V. Weston 301, 3" Square or 3½" R.B. ..... @ $11.50
0-4 K.V. DeJur Amsco, 3½" R.B. ..... @ $8.50
0-4 K.V. DeJur Amsco, 3½" R.B. without holster ..... @ $4.50
0-5 K.V. Weston 301, 3" S.B. or 3½" R.B. ..... @ $12.50
0-5 K.V. Westinghouse NX-35, 3½" R.B. ..... @ $11.00
0-7.5 K.V. Weston 301, 3" S.B. or 3½" R.B. ..... @ $14.50
0-10 K.V. Weston 301, 3" S.B. or 3½" R.B. ..... @ $17.50
0-15 K.V. Westinghouse NX-35, 3½" R.B. without resistor ..... @ $4.95
0-20 K.V. Weston 301, 3" S.B. or 3½" R.B. ..... @ $23.50
0-20 K.V. General Electric DO-41, 3½" R.B. ..... @ $19.50
0-20 K.V. General Electric DO-41, 3½" R.B. 500 microampere movement without resistor ..... @ $4.95
0-25 K. V. Westinghouse NX-35, 3½" R.B. 1 milliampere movement, without resistor ..... @ $4.50

SPECIAL METERS

SENSITROL RELAY 0-50 Microampere Sensitivity, Ideal for any application where a high sensitivity, and high contact capacity D.C. Relay is specified. Weston 707 type 5. Single fixed contact with 110 volt A.C. solenoid reset and adjustable index to indicate operating point. Has two scales, one for setting index and the other for reading pointer position. Contact closes on decreasing value and has a capacity of 3 watts at 110 volts. Comes in a 3" round surface mounted metal case with the solenoid unit projecting through the rear.
Current List Price $68.50 Your Cost Only $27.50

FREQUENCY METER, DUAL RANGE covers frequency range from 48 to 52 and 58 to 62 cycles. Dual element, vibrating reed type. Operates from 100 to 150 volts, 3½" round flush metal case. If you have a generating system or for any reason must maintain a constant frequency on your equipment, this is the ideal meter for you.
A real value at only $5.95

FREQUENCY METER, RANGE 55 to 60 CYCLES James Biddle Company type MF-11. Frahm vibrating reed type, 11 reeds, 100 to 150 volt operation, 2½" round flush bakelite case ..... As only $7.50

SIGNAL STRENGTH "S" METER
Use this on the plate circuit of your receiver to show the relative strength of incoming signals. Scale calibrated minus 6 to 100 DB above 1 microvolt. 5 M.A. zero right movement with TRANSLUCENT SCALE, REAR MOUNTED INTERNAL SHUNT, AND 6 VOLT LAMP TO ILLUMINATE SCALE. A Simpson model 25, 3½" round flush bakelite case meter. Full details and circuits can be found in the Radio Amateurs Handbook. A really nice meter to dress up your radio shack.
Only $4.50

RECTIFIER TYPE MILLIAMMETER 270 degrees wide angle movement. Weston model 545 type 81, Concentric scale, 4½" Aircraft type. Full scale is 1.1 M.A. AC with a 940 microampere 70 ohm D.C. movement and rectifier, black scale calibrated directly in degrees 0-270 ..... @ $6.50

RECTIFIER TYPE MILLIAMMETER, McClintock, 2" Round flush metal case ring clamp mounted (non-flanged case) 1 MA A.C. has a 700 microampere D.C. movement with a half wave rectifier ..... @ $2.50

RPM INDICATOR zero center, D.C. milliammeter, movement 1-0-1 MA Weston model 502, 6" square flush metal case. Black scale calibrated 900-0-900 R.P.M. ..... @ $18.00

RPM INDICATOR, zero center D.C. Milliammeter, movement 2.4-0-2.4 MA. Westinghouse SS, 7½" round surface mounted case ..... @ $8.50

MICRORANGE, HIGH SPEED DECIBEL METER AN IDEAL METER FOR RECORDING SOUND, BROADCASTING, TELEPHONE, AND TELEGRAPH APPLICATIONS. Weston, type 61, GRAUH APPLICATIONS. Weston, type 61, can be supplied in either the 3½" round or 3" square flush bakelite case, minus 10 to plus 6 DB, 6 MW in 600 ohms, zero DB equals 1.9 volts, and 5000 ohms. High speed type 2 to 3.5 seconds to total deflection reading. Only 2–6% overthrow, 16-50 Damping factor. Complete with 3 external wire wound precision resistors to extend the range.
Total Price for Meter and Rod Only $11.50

DECIBEL METER, GENERAL PURPOSE TYPE, Weston 301 type 21, minus 10 to plus 6 DB, zero DB equals 1.9 volts at 5000 ohms, 6 MW in 600 ohms. 3" square flush bakelite case ..... @ $8.50

DECIBEL METER, GENERAL PURPOSE type, Weston 301 type 25, minus 10 to plus 6 DB zero DB equals 0.6 volts, 6 MW in 600 ohms, 3½" round flush bakelite case ..... @ $8.50

DECIBEL METER General Electric type DO-46, minus 10 to plus 6 DB, zero DB equals 1.9 volts & 5000 ohms, 6 MW in 600 ohms. 3" square flush bakelite case ..... @ $7.95

PORTABLE TACHOMETERS

0-20,000 RPM Range, Jaeger 243 A-6 Chronometric type $24.50

300-1200, 1000-4000, 3000-12000 RPM, Jones Motorola Co., Multiple Range, Continuous indicating $24.50

300-1500, 1000-5000, 3000-15000 RPM, Jones Motorola Co., Multiple Range, Continuous Indicating $25.00

SOCKET SELECTOR SET WESTON 666 TYPE 1C

Designed for purpose of taking readings of currents, voltages and resistances and other electrical measurements in a vacuum tube circuit. It can be used with many Western Analyzers or other make multirange volt-ohm-milliammeters. To test a tube circuit the tube is plugged into the appropriate adapter and the test plug inserted in the tube socket. This brings all currents and voltages out through a cable where they may be measured with an analyzer.
Complete with Tube Base Data Connections and Chart, 15 Adapters, pin leads and test block.
List Price $30.00 ..... Your Cost $9.50

COMBINATION OFFER

150 VOLT A.C. METER	30 AMP A.C. METER
Triplett 331-JP, 3½" Rd flush case	Triplett 331-JP, 3½" Rd flush case

Both meters for $7.95

TESTED NEW PANEL METERS

EACH METER TESTED BEFORE SHIPMENT. CALIBRATIONS ARE FOR NON MAGNETIC PANELS. IF METERS ARE FOR USE ON MAGNETIC PANELS SPECIFY PANEL THICKNESS AND WE WILL CALIBRATE ACCORDINGLY AT NO EXTRA CHARGE. All meters have white scale and are flush mounted unless specified otherwise.

S—Square	M—Metal	sc—scale
R—Round	V—Ohms per volt	surf—surface mounted
B—Bakelite	bl—Black	

ALL ITEMS ARE BRAND NEW SURPLUS GUARANTEED. All materials shipped from stock same day as order received, subject to prior sale. Orders accepted from rated concerns, public institutions and agencies on open account, others please send 25% deposit, balance C.O.D. or check with order. All prices FOB our warehouse, N.Y.C.

MARITIME SWITCHBOARD
338 CANAL STREET
NEW YORK, 13, N. Y.
Worth 4-8217

FULLY GUARANTEED **BRAND NEW SURPLUS OFFERED BY A LEADING**

A.C. MOTORS

5071930, Delco, 115 V., 60 Cycle, 7000 r.p.m. **Price $4.50 each net.**

36938-2, Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 4/5 r.p.m. **Price $3.00 ea. net.**

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 3.2 w., 4 r.p.m., with brake. **Price $4.00 each net.**

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 2.2 w., 1.240 r.p.m. **Price $3.00 each net.**

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 2.3 w., 1 r.p.m. **Price $2.70 each net.**

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1.1/5 r.p.m. **Price $2.70 each net.**

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 3.5 w., 1 r.p.m. With shift unit for automatic engaging and disengaging of gears. **Price $3.30 each net.**

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1/60 r.p.m. **Price $3.00 each net.**

Eastern Air Devices Type J33 Synchronous Motor 115 V., 400 cycle, 3 phase, 8,000 r.p.m. **Price $8.50 each net**

Telechron Synchronous Motor, Type B3, 115 V., 60 cycle, 2 r.p.m., 4 w. **Price $5.00 each net.**

Barber-Colman Control Motor, Type AYLC 5091, 24 volts D.C. .7 amps 1 R.P.M., Torque 500 in. lbs. Contains 2 adjustable limit switches with contacts for position indication. Ideal for use as a remote positioner or a beam or television antenna rotator, will operate on A.C. 60 cycle. **Price $6.50 each net.**

SERVO MOTORS

CK 1, Pioneer, 2 phase, 400 cycle. **Price $10.00 each net.**

CK 2 Pioneer, 2 phase, 400 cycle. **Price $4.25 each net.**

10047-2-A Pioneer 2 phase, 400 cycle, with 40:1 reduction gear. **Price $7.25 each net.**

FPE-49-6 Diehl, Low-Inertia, 115 V., 60 cycle, 2 phase, 3 amps., 10 watt output. **Price $34.50 each net.**

FPE-25-16 Diehl Low-Intertia 20 V., 60 cycle, 2 phase, 1600 r.p.m., 85 amps. **Price $10.00 each net.**

CK 2, Pioneer, 2 phase, 400 cycle, with 40:1 reduction gear. **Price $6.50 each net.**

MINNEAPOLIS-HONEYWELL TYPE B Part No. G303AY, 115 V., 400 cycle, 2 phase, built-in gear reduction, 50 lbs. in torque. **Price $8.50 each net.**

AMPLIFIER

Pioneer Gyro Flux Gate Amplifier, Type 12076-1-A. **Price $17.50 ea. net, with tubes.**

REMOTE INDICATING MAGNESYN COMPASS SET

Pioneer Type AN5730-2 Indicator and AN5730-3 Transmitter 26 V., 400 cycle. **Price $40.00 per set new sealed boxes.**

Kollsman Remote Indicating Compass Set Transmitter part No. 679-01, indicator part No. 680k-03, 26 V., 400 cycle. **Price $12.50 each net.**

GYROS

Schwein Free & Rate Gyro type 45600. Consists of two 28 V. D.C. constant speed gyros. Size 8" x 4.25" x 4.25". **Price $10.00 ea. net.**

Schwein Free & Rate Gyro, type 46800. Same as above except later design. **Price $15.00 ea. net.**

Sperry A5 Directional Gyro. Part No. 656029, 115 volts, 400 cycle, 3 phase. **Price $17.50 each net.**

Sperry A5 Vertical Gyro. Part No. 644841, 115 V., 400 cycle, 3 phase. **Price $20.00 each net.**

Sperry A5 Amplifier Rack Part No. 644890. Contains Weston Frequency Meter, 350 to 450 cycle and 400 cycle, 0 to 130 voltmeter. **Price $10.00 each net.**

Sperry A5 Control Unit Part No. 644836. **Price $7.50 each net.**

Sperry A5 Azimuth Follow-Up Amplifier Part No. 656030. With tube. **Price $5.50 each net.**

Pioneer Type 12800-1-D Gyro Servo Unit. 115 V., 400 cycle, 3 phase. **Price $10.00 each net.**

Norden Type M7 Vertical Gyro. 26 V., D.C. **Price $19.00 each net.**

Allen Calculator, Type C1 Bank and Turn Indicator, Part No. 21500, 28 V. D.C. Contains 28 V. D.C. constant speed gyro. **Price $10.00 each net.**

D.C. MOTORS

5069625, Delco Constant Speed, 27 V., 120 r.p.m. Built-in reduction gears and governor. **Price $3.90 each net.**

A-7155, Delco Constant Speed Shunt Motor, 27 V., 2.4 amps., 3600 r.p.m., 1/30 h.p. Built-in governor. **Price $6.25 each net.**

C-28P-1A, John Oster Series Motor, 27 V., 0.7 amps., 7000 r.p.m., 1/100 h.p. **Price $3.75 each net.**

Jaeger Watch Co. Type 44-K-2 Contactor Motor. Operates on 3 to 4.5 volts D.C. Makes one contact per second. **Price $2.00 each net.**

General Electric Type 5BA10AJ52C, 27 V. D. C., 0.65 amps., 14 oz. in. torque, 145 r.p.m. Shunt Wound, 4 lead reversible. **Price $5.00 each net.**

General Electric Type 5BA10AJ37C, 27 V. D. C., 5 amps., 8 oz., in. torque, 250 r.p.m. Shunt Wound, 4 leads reversible. **Price $6.50 each net.**

D.C. ALNICO FIELD MOTORS

5067043 Delco 12 volts, 10,000 r.p.m. **Price $5.50 each net.**

5069466, Delco, 27 V., 10,000 r.p.m. **Price $3.50 each net.**

5069370, Delco, 27 V., 10,000 r.p.m. **Price $5.00 each net.**

S. S. FD6-16, Diehl, 27 V., 10,000 r.p.m. **Price $4.00 each net.**

S. S. FD6-18, Diehl, 27 V., 10,000 r.p.m. **Price $4.00 each net.**

S. S. FD6-21, Diehl, 27 V., 10,000 r.p.m. **Price $4.00 each net**

Sampsel Time Control Inc. Alnico Field Motor, 27 V. D.C. Overall length 3 5/16" by 1 3/8". Shaft 3/8" long by 3/16", 10,000 r.p.m. **Price $4.50 each net.**

GENERAL ELECTRIC D. C. SELSYNS

8TJ9-PDN Transmitter, 24 V. **Price $3.75 each net.**

8DJ11-PCY Indicator, 24 V. Dial marked—10° to +65° **Price $4.50 each net.**

8DJ11-PCY Indicator, 24 V. Dial Marked 0 to 360°. **Price $7.50 each net.**

RELAYS

Type B4 28 volts D.C., 200 amps. continuous duty. Electric Auto-Lite Co. Part no. WSN4001 **Price $2.50 each net.**

Type B5B, 28 volts D.C., 50 amps., continuous duty Hart Mfg. Co. Part no. 692R6 **Price $1.85 each net.**

Type B8, 28 volts D. C., 250 amps., intermittent duty Cutler-Hammer. Part no. 6041H139A **Price $2.50 each net.**

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Wincharger Corp. Dynamotor Unit. PE 101-C. Input 13. V.D.C. or 26 V.D.C. D.C. AT, 12.6 or 6.3 amps. Output 400 V.D.C. AT .135 amps., 800 V.D.C. AT .02 amps., 9 V.A.C. 80 cycle at 1.12 amps.
Price $10.00 each net.

153F, Holtzer Cabot, Input, 24 V.D.C. Output 115 V., 400 cycle, 3 phase, 750 V.A. and 26 V., 400 cycle, 1 phase, 250 V.A. Voltage and frequency regulated also built in radio filter.
Price $115.00 each net.

149H, Holtzer Cabot. Input 28 V. at 44 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $40.00 each net.**

149F, Holtzer Cabot. Input 28 V. at 36 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $40.00 each net.**

12117, Pioneer. Input 12 V.D.C. Output 26 V., 400 cycle, 6 V.A.
Price $22.50 each net.

12117-2 Pioneer. Input 24 V.D.C. Output 26 V. 400 cycle, 6 V.A.
Price $20.00 each net.

12116-2-A Pioneer. Input 24 volts D.C., 5 amps. Output 115 volts 400 cycle single phase 45 watts.
Price $100 each net.

5D21NJ3A General Electric. Input 24 V.D.C. Output 115 V., 400 cycle at 485 V.A. **Price $12.00 each net.**

PE218, Ballentine. Input 28 V.D.C. at 90 amps. Output 115 V., 400 cycle at 1.5 K.V.A. **Price $50.00 each net.**

METERS

Weston Frequency Meter. Model 637, 350 to 450 cycles, 115 volts.
Price $10.00 each net.

Weston Voltmeter. Model 833, 0 to 130 volts, 400 cycle. **Price $4.00 each net.**

Weston Voltmeter. Model 606, Type 204 P, 0 to 30 volts D. C.
Price $4.25 each net.

Weston Ammeter. Model 506, Type S-61209, 20-0-100 amps. D. C.
Price $7.50 each net with ext. shunt.

Weston Ammeter. Type F1, Dwg. No. 116465, 0 to 150 amps. D. C.
Price $6.00 each net.
With ext. shunt $9.00 each net.

Westinghouse Ammeter. Type 1090-D120, 120-0-120 amp. D. C.
Price $4.50 each net.

Weston Model 545. Type 82PE Indicator. Calibrated 0 to 3000 RPM 2¾" size. Has built-in rectifier, 270° meter movement.
Price $15.00 each net.

VIBRATOR

Rauland Corp. vibrator non-synchros type Stock No. 3H6694-11; 6, 12 or 24 V.D.C., Input. Frequency 200 cycle.
$3.50 each net.

Sperry Phase Adapter. Part No. 661102. Used for operating three-phase equipment from a single phase source. 115 volts 400 cycle. Maximum load 500 watts. **Price $15.00 each net.**

PIONEER AUTOSYNS

AY1, 26 V., 400 cycle.
Price $5.50 each net.

AY14D, 26 V., 400 cycle, new with calibration curve.
Price $15.00 each net.

AY20, 26 V., 400 cycle.
Price $7.50 each net.

AY5 26V., 400 cycle. Has hollow shaft.
Price $7.50 ea. net

PRECISION AUTOSYNS

AY101D, new with calibration curve.

PRICE—WRITE OR CALL FOR SPECIAL QUANTITY PRICES

AY131D, new with calibration curve.
Price $35.00 each net.

AY130D, new. **Price $35.00 each net.**

PIONEER AUTOSYN POSITION INDICATORS

Type 5907-17. Dial graduated 0 to 360°, 26 V., 400 cycle.
Price $15.50 each net.

Type 6007-39, Dual, Dial graduated 0 to 360°, 26 V., 400 cycle.
Price $30.00 each net.

PIONEER TORQUE UNIT

Type 12602-1-A.
Price $40.00 each net.

Type 12606-1-A. Price $40.00 each net.
Type 12627-1-A. Price $80.00 each net.

MAGNETIC AMPLIFIER ASSEMBLY

Pioneer Magnetic Amplifier Assembly Saturable Reactor type output transformer. Designed to supply one phase of 400 cycle servo motor.
Price $8.50 each net.

PIONEER TORQUE UNIT AMPLIFIER

Type 12073-1-A, 5 tube amplifier, Magnesyn input, 115 V., 400 cycle
Price $17.50 each net with tubes

BLOWER ASSEMBLY MX-215/APG

John Oster, 28 V.D.C., 7000 r.p.m. 1/100 h.p. **Price $4.50 each net.**

Westinghouse Type FL Blower, 115 V., 400 cycle, 6700 r.p.m., Airflow 17 C.F.M. **Price $3.70 each net.**

RATE GENERATORS

PM2, Electric Indicator Co., .0175 V. per r.p.m. **Price $8.25 each net.**

F16, Electric Indicator Co., two-phase, 22 V. per phase at 1800 r.p.m.
Price $12.00 each net.

J36A, Eastern Air Devices, .02 V. per r.p.m. **Price $9.00 each net.**

B-68, Electric Indicator Co., Rotation Indicator, 110 V., 60 cycle, 1 phase.
Price $14.00 each net.

Weston Tachometer Generator (aircraft type) model 752-J4 single phase. A.C. output **Price $17.50 each net.**

SINE-COSINE GENERATORS (Resolvers)

FPE 43-1, Diehl, 115 V., 400 cycle.
Price $20.00 each net.

SYNCHROS

1F Special Repeater, 115 V., 400 cycle. Will operate on 60 cycle at reduced voltage.

Price $15.00 each net.

7G Generator, 115 V., 60 cycle.
Price $30.00 each net.

2J1F3 Selsyn Generator 115 volts, 400 cycle. **Price $5.50 each net.**

2J1M1 Control Transformer 105/63 V., 60 cycle. **Price $20.00 each net.**

2J1G1 Control Transformer, 57.5/57.5 V., 400 cycle. **Price $1.90 each net.**

2J1H1 Selsyn Differential Generator, 57.5/57.5 V., 400 cycle.
Price $3.25 each net.

W. E. KS-5950-L2, Size 5 Generator, 115 V., 400 cycle.
Price $4.50 each net.

5G Generator 115 volts, 60 cycle.
Price $50.00 each net.

5G Special, Generator 115/90 V., 400 cycle. **Price $15.50 each net.**

5SF Repeater, 115/90 V., 400 cycle.
Price $19.00 each net.

2J1F1 Selsyn Generator, 115 V., 400 cycle. **Price $3.50 each net.**

5SDG Differential Generator 90/90 V., 400 cycle. **Price $12.00 each net.**

1CT Control Transformer. 90/55 volts, 60 cycle. **Price $40.00 each net.**

POSITION TRANSMITTER

Pioneer Type 4550-2-A Position Transmitter, 26 volts 400 cycle, gear ratio 2:1. **Price $15.00 each net.**

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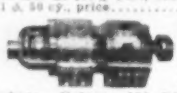
CENTURY MOTOR GENERATOR SETS

Motor: 32 volts, D.C. 5 H.P., sh. wdg., 1800 R.P.M. directly connected to alternator delivering 120 volts, A.C., 3.75 K.V.A., emb. wdg., Single Ph., 60 cps. Complete with spare parts, controlling field rheostat. Brand New **$355.00**

Continental Motor Generator Sets, Type 108 445X, operative at 230 Volts DC, 1800 RPM, stab. sh. output 35 KVA., .8 P.F., 120 volts, 3 ϕ, 60 cy., weight app. 1600 lbs., rebuilt, price **$490.00**

Admiralty Motor Generator Set, British mfg., input 200/230 VDC, 1500 RPM, output 10 KW at 100% P.F., 230 volts, 43.5 amps., 1 ϕ, 50 cy., price **$795.00**



Ideal AC to DC MG set 300 watts. Rebuilt like new. Ideal MG Set, operative at 110/220 VAC, single phase. Output: 120 VDC, 2.5 amperes. Special Price **$65.00**

ESCO CONVERTERS

Rebuilt like new. Input: 86 VDC 2.85 amp. 3600 R.P.M. Output 115 VAC 2.18 amp. .50 P.F. Ball Bearings. Base for table or side mounting. Special **$9.80**

ESCO DC/AC MG SETS, Motor: 115 Volts, 1½ HP, line start; built in voltage regulator, frequency control, filtered; ideal for television, radar or any application requiring constant voltage and frequency. Brand New **$120.00**

CENTURY MOTOR GENERATOR SETS

7.5 KW: 230 Volts DC to 115 Volts, AC, single phase, 60 cycles. Complete with automatic controller and push button station **$445.00**

GENERAL ELECTRIC DC/AC MG SETS

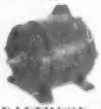
Four Bearing Marine Units: 25 HP, 230 Volts DC coupled to alternator 18.75 KVA, 80% PF, 1800 RPM, Ball Bearings, 4 bearing set; marine duty. Brand New **$545.00**

General Electric "Variac type" Controllers; 600 watts; 110/220 designed as an adjustable speed controller but can be used for any application requiring a variable transformer. Brand new and an exceptional buy at **$12.00**

GE Relays: 110 VAC—10 Amp. 58/60 cy. in steel case 3 x 3 x 6¾ **$3.90**

Shaded Pole Motor with gear train on mounting bracket, 110 VAC **$1.65**

Westinghouse Transformer Controller contains 500 watts 120-220 volt transformer with multi-taps. The transformer with fan switch alone is worth more than the **special price** **$6.25**



General Electric Synchronous Motor or Alternator; operation 2 Volts operating at or delivering 110 volts, 1 phase, 60 cycles at 1800 speed; no name plate, but lab tests determined specs as above **$9.50**

RAYTHEON HIGH VOLTAGE TRANSFORMERS; Pri: 214/245 Volts. Sec: 5500 Volts, 1.6 amperes. Test 13,500 V. Brand New **$72.00**

Esco AC Motors; built-in magnetic brake for quick reversing. Double shaft, ball bearings. Rated 2½ HP—30 minutes, marine duty; 440-3-60. Brand new in original cases ..... **SPECIAL PRICE $28.50**

G. E. Motor Starting Reactors Type 11K2840G2; Rated at 440V. 1 Ph. 60 cy. 16.8 Amp. Only a 3 Pole Double Throw Switch is necessary with this unit to make a 15-20 HP compensator starter. Useful for any purpose requiring three phase chokes ..... **SPECIAL PRICE** **$9.90**

Esco AC Motors; built-in magnetic brake for quick reversing. Double shaft, ball bearings. Rated: 2½ HP—30 minutes, marine duty; 440-3-60. Brand new in original cases ..... **SPECIAL PRICE $28.50**

GEN. EL. AMPLIDYNES

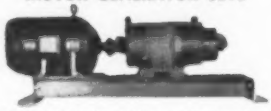
Model 5AM78AB16; 750 watts; Input: 440-3-60. Output: 250 Volts, DC, 2 amperes, 3450 RPM **$115.00**

Coupled directly to control motor on common base. Brand new **$185.00**

Model 5AM73AB58; 375 watts. Input: 110/220 v. 1 ϕ, 60 cy. Output: 250 VDC, 1.5 Amp. **$58.00**

Model 5AM78AB111; 1500 watts; Input: 208 V. 3 ϕ, 60 cy. Output: 250 VDC, 6 amp. **$225.00**

LELAND-MURRAY HIGH FREQ. MOTOR GENERATOR SETS



3 KVA: 120 Volts, 3 Phase, 400 cycles, coupled to 220/440-3-60 Motor **$335.00**

Same unit with 5 HP-110/220 Volt Motor **$415.00**

Electric Specialty High Frequency Converter Units. Primary: 22 VDC, 18 amperes, 3000 R.P.M. Ball Bearings. Secondary: 350 volts, 1500 cycles, 785 amps 275 V.A. Single Ph. Built-in frequency control. Specially Priced at **$30.00**

ONAN 400 CYCLE MG SETS: Operative at 110/220 VAC 1 ϕ, 60 cyc, belted to alternator rated 1.2 KVA; 115 V, 1 ϕ, 800 Cy **$251.00**

Above unit with 220/440-3-60 motor **$227.00**

ONAN 500 CYCLE MG SETS: 4 KVA—Operative with 110/220 VAC, 1 ϕ, 60 Cy. Motor, rep-ind. Output single ph. **$450.00**

With 3 Ph. 220/440 Motor **$395.00**

HIGH FREQUENCY MG UNIT. Made by Quality Elect. Operates at 115 VAC, 1 ϕ, 60 cy. delivers 115 VAC, 87 amp. 2000 C. P. S. also 200/1000 VDC at 25/3 amp. self excited with panel containing starting control. Unit is 50" long, weighs 700 lbs. **$145.00**

HOLTZER-CABOT MG 149F

Input: 28 Volts, DC at 36 amps. Output 26 Volts at 240 V. A. 400 cps. and 115 Volts at 200 V. A. 400 cycles. Rebuilt, like new **$24.75**

ONAN HIGH FREQUENCY MG UNITS

Input: 110/220, single phase, 60 cyc. Output: .6 K.W. 115 VAC, single ph. 480 cps. Rebuilt like new **$138.50**

500 CYCLE M-G SETS

British made motor generator, .8 KW, 2 bearing unit, input 180/240 VDC, output 180 volts, 1 ϕ weight app. 1000 lbs. price **$425.00**

INDUCTION VOLTAGE REGULATOR Type IRT, form M. 164 KVA, 3 phase, 60 cycles, cont. duty. Outdoor service. Primary: 208 V., 10.5 load amps. Oil-filled. Wgt. 365 lbs. 23 x 17" x 24" **$83.00**

PINCOR ROTARY CONVERTERS

200 VA. Filtered. Brand New. Input: 115 VDC 4.2 Amp. Output: 720 VAC, 1.36 Amp. **SPECIAL PRICE** **$38.00**

GENERAL ELECTRIC DC GENERATORS: Type BD-1, ⅝ K. W. 125/125 Volts, 14 Amps, 1800 Speed Rebuilt **$65.00**

G. E. Motor CONTROLLED VOLTAGE REGULATOR

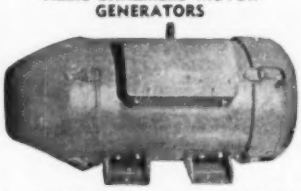
Cat. 8837625, Type AIRS, Form M. 548 KVA, cont. duty, 60 cy., primary volts 115. Load Amps 16.2. Indoor service. Voltage controlled by mtr. 150/1/60, 1/20 HP **$39.50**

MARATHON MOTOR GENERATORS

Input: 110 VDC Output: 110 VAC, 1 phase, 60 cy 500 VA Marine Type with voltage regulator and frequency controller. Rebuilt **$63.00**

Same unit as above with 32 VDC input and same Output, 500 V.A. **$54.00**

ALLIS-CHALMERS MOTOR GENERATORS



Input: 115 VDC at 14 amps. 3600 RPM. Ball Bearings. Output: 1.25 KVA, 80% PF 120 Volts, AC. 1 Ph. 10.4 amps. Centrifugal automatic controller permits line-start operation. Fully enclosed. **Brand New $99.95** Also available for 230 VDC operation at the same price.

GEN. ELECTRIC TRANSFORMERS

1 KVA: 460/230-230/115. Brand New **$19.60**

Used, guaranteed, do. **12.50**

2 KVA: used do. **19.75**

5 KVA: used do. **44.00**

General Electric 5 KVA Autotransformers; 110/220; Brand New **$26.00**

G.E. OIL FILLED OUTDOOR TRANSFORMER

Brand New. 3 KVA; Type HS 3000/5200Y-115/230. **SPECIAL PRICE. Brand New** **$36.00**

RAYTHEON DISTRIBUTION TRANSFORMERS; 75 KVA. Pri: 220/240; Sec: 110 Volts, single phase, 60 cycles. Brand New **$15.50**

WESTINGHOUSE TRANSFORMERS

300 VA; 115/240 Volts; Brand New. **SPECIAL PRICE $3.35**

Westinghouse Precipitron Transformers. Pri: 110 V. Sec: 12,000 Volts, 18 MA **$3.98**

New 1 Cylinder-2 Cycle 1 HP. GAS ENGINE

Air cooled lightweight aluminum construction, 1¾ bore x 2¾ stroke. 3600 R.P.M. Precision built, covered by manufacturer's warranty **$29.00**

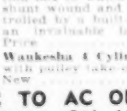
Marathon Generators can be used with above engine. Have output of 110 Volts AC, 1 ϕ, 60 cy. 300 Watts, rebuilt, special price **$33.50**

Century Repulsion Induction Motor, type Rs. 1/6 HP, 110 or 220 Volts, 1 ϕ, 1750 RPM, rebuilt **$5.75**

General Electric, DC motor, Type SD, 1/20 HP, R.H., 110 Volts, 2 amps, sh. wdg., price **$3.35**

G. E. DC Motor, type BY, 1/17 HP, 2100 RPM, sh. wdg., BB., price **$3.00**

Westinghouse Inerteen capacitor for precipitron service, DC volts per section 2500; resistance 6.25 megohms, .15 mfd. per section, price **$4.00**



TAPE WINDERS

These tape winders consist of a motor operative at 110 volts D.C., 6 amperes, 1800 speed. A motor, which is separable from the rest of the unit, and which can be employed for a multitude of purposes, alone or with the gear reduction box to which it is connected. Motor is shunt wound and the speed thereof is controlled by a built-in rheostat. This makes an invaluable laboratory unit. Special Price **$10.99**

Waukesha 4 Cylinder Gas Engines 10 HP with pulley take-off, crank starting. Brand New **$148.50**

IF IT'S FROM ONE FREQUENCY TO ANOTHER; FROM DC TO AC OR AC TO DC; IF IT'S ONE VOLTAGE TO ANOTHER, THEN CALL ON US.

Established in 1922 **WILLIAM I. HORLICK COMPANY** *Tel HAncock 6-2480*

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- TUBES
- WAVEGUIDE
- WAVEMETERS
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RADIO HAM SHACK broadcasts its sincere thanks to all its old friends and a hearty welcome to new ones.

TO OUR OLD FRIENDS. It is not news that **RADIO HAM SHACK** is the house of value. They know that our mass purchasing policy of vast quantities of surplus equipment and the maintenance of one of the largest stocks of radio tubes and electronic components in the United States enables us to offer them low, low prices that are difficult to beat anywhere in the world.

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OB3/VR90	.65	3C23	2.19	249C	1.49	826	.39	C1A	9.95	6J4	.97	6A4	.97	6SN7GT	.54	12Z3	.69
OC3/VR105	.69	3C24/24G	.35	250R	5.95	828	10.95	C5B	6.95	6J4A	1.09	6A4LA	1.09	6SQ7	.45	14A4	.79
OD3/VR150	.48	3C30-S09	1.89	250TH	18.95	829	7.45	C8A	7.95	1A3	.44	6A6	.79	6SR7GT	.52	14A7	.82
1B21		3C31-C1B	2.98	250TL	18.95	830B	3.19	C8J	3.65	1A4	1.09	6A7	.69	6SS7	.49	14B6	.69
GL471A	2.87	3C45	12.95	271B	2.69	832A	4.89	C100D	3.95	1A4P	.97	6A8	.77	6ST7	.72	14Y7	.79
1B22	2.87	3CP1	1.39	293A	2.98	833A	33.95	CK502AX	2.25	1A5GT	.49	6AB7	.79	6SU7GTY	1.25	14E8	.79
1B23	8.75	3DP1	1.79	294A	2.95	836A	1.97	CK503AX	1.95	1A6	.79	6AC7	.74	6SV7	.79	14H7	.69
1B24	4.59	3DP1-S2A	2.79	300B	9.95	837	1.19	CK505AX	2.25	1A7GT	.67	6AD7G	1.89	6T7G	.89	14J7	.85
1B26	2.79	3D21A	.98	304TH	3.49	838	1.98	CK506AX	1.95	1AB5	.59	6AF8G	.79	6U5G	.65	14N7	.85
1B27	7.95	3EP1	2.59	304TL	1.29	841	.29	CK507AX	1.95	1B3/8016	1.15	6AG5	.69	6U8GT	.63	14Q7	.85
1B29	.79	3E29	8.95	305A	24.95	843	.29	CK512AX	2.25	1B4	1.19	6AG7	.98	6U7G	.49	14R7	.69
1B32	1.89	3FP7	.97	307A	3.69	845	4.25	CK571AX	8.65	1B5/25S	.99	6AH6	1.29	6V6	.89	19	.69
1B36	3.95	3GP1	5.95	316A	.29	851	12.95	CK1005	.99	1C5GT	.59	6AJ5	.79	6V6GT	.57	24A	.49
1B38	36.50	3HP7	3.95	327A/5C37	2.25	860	16.95	CK1006	.85	1C6	.89	6AK5	.85	6W4	.63	25L6GT	.53
1B21	3.75	4-65A	14.21	331A	12.95	861	9.95	CK1007	.89	1C7G	.89	6AK6	.79	6W7G	.77	25Z5	.69
1N21	.49	4-125A	26.05	350A	1.19	864	.29	EL91	.29	1D5GP	.97	6AL5	.59	6X4	.57	25Z6GT	.53
1N21A	.89	4-250A	36.25	350B	1.39	868	.79	EF50	.39	1D7G	.89	6AQ5	.49	6X5GT	.47	26	.49
1N21B	1.39	4AP10	1.98	368A/B	4.98	868A	1.05	FG23A	7.95	1D8GT	.95	6AQ6	.69	6Y6G	.67	27	.49
1N22	.98	4B22	9.98	371B	.49	869B	1.05	FG27A	15.95	1F4	.75	6AR5	.89	6Y7G	.94	28D7	.98
1N23	.79	4B24	1.98	388A	.47	869B	26.50	FG28A	69.50	1F5G	.75	6AT6	.64	6ZY5G	.59	30	.37
1N23A	.79	4B25	7.95	393A	3.69	872A	1.12	FG68	37.50	1G4GT	.69	6AT6	.59	7A4/XXL	.49	31	.98
1N23B	1.89	4B26	4.49	394A	3.69	874	.39	FG69	49.50	1G6GT	.65	6AV6	.47	7A5	.59	32	.98
1N27	.25	4B28	2.47	417A	9.95	878	.29	FG92A	397.50	1E7G	1.15	6BA6	.59	7A7	.58	32L7GT	.69
1N34	.82	4B32	9.95	446A	1.25	878	1.98	FG17	2.69	1H4G	.55	6B6G	.79	7AG7	.72	33	.69
1P23	2.49	4C35	19.38	446B	1.29	884	1.19	FG27A	6.95	1H5GT	.54	6B7	.87	7B4	.53	34	.37
1P24	.59	4D32	9.95	450TH	19.95	885	1.19	FG32	4.95	1H6GT	.87	6B8G	.69	7B5	.67	35/51	.57
1P36	2.85	4D32	9.95	450TL	44.50	902	3.39	FG33	7.95	1H6	.75	6BA6	.58	7B6	.56	35A5	.68
1R21	3.95	4E27		527	5.95	905	2.49	FG57	12.95	1L4	.68	6BE6	.52	7B7	.59	35B5	.58
2AP1	3.89	257B	12.45	559	.98	908	4.95	FG81A	3.29	1L4A	.79	6BF6	.87	7C4	.54	35C5	.59
2C21/RK33	.24	5AP1/RK35	2.98	575A	11.95	915	1.49	FG105A	9.95	1L6	.89	6BG6G	1.49	7C5	.58	35L6	.58
2C22/7193	.15	5AP4	2.95	631P1	3.75	919	1.95	FG172	13.95	1LB4	.89	6BH6	.59	7C7	.59	35W4	.39
2C26A	.15	5BP1	2.29	700A	19.95	923	.79	FG190	12.95	1LC5	.69	6BJ6	.57	7E5	.67	35Y4	.49
2C34/RK34	.24	5BP4	7.39	700B	19.95	927	1.25	GL146	9.95	1LC6	.79	6C4	.19	7E6	.54	35Z3	.59
2C39	17.95	5CP1	1.29	700C	19.95	930	.98	GL434A	2.69	1LD5	.79	6C5	.49	7E7	.58	35Z4	.44
2C40	4.95	5CP7	2.95	700D	19.95	931A	2.98	GL471A	2.85	1LE3	.69	6C6	.57	7F7	.59	35Z5	.59
2C43	7.95	5D21	24.45	701A	3.95	954	.16	GL502	89.50	1L5	.79	6C8G	.69	7H7	.59	36	.69
2C44	.98	5EP7	1.98	702A	2.69	955	.25	GL697	69.50	1LH4	.79	6D6	.44	7J7	.87	37	.98
2C45	6.95	5GP1	2.98	703A	1.89	956	.25	HF100	6.95	1LN5	.67	6D8G	.79	7L7	.69	38	.37
2C51	5.95	5JP1	39.50	704A	1.49	957	.22	HF125A	14.95	1N5GT	.59	6E5	.69	7N7	.67	39/44	.37
2D21	.89	5JP2	8.95	705A	.69	958	.22	HF200	14.95	1P5GT	.67	6F5	.47	7Q7	.59	41	.69
2D29	1.39	5JP4	39.50	706B	19.95	959	.55	HF300	17.45	1S5GT	.67	6F6	.57	7T7	.69	42	.49
2E22	1.19	5JP7	12.95	706CY	18.75	991/NE16	.24	HY114B	.69	1R4	.59	6F6GT	.57	7V7	.87	43	.49
2E26	3.39	5JP9	12.95	706EY	47.50	1613	.49	HY115	.59	1R5	.69	6F7	.69	7W7	.79	45	.52
2E30	2.39	5JP11	47.50	706GY	47.50	1614	1.35	HY614	.95	1S4	.59	6F8G	.87	7Y4	.57	45Z3	.57
2J21A	7.95	5LP1	12.95	707B	14.95	1616	.49	HY615	6.95	1S5	.49	6G6G	.69	7Y4	.47	45Z5	.55
2J22	2.95	5MP1	9.95	708A	3.59	1619	.17	KU627	6.95	1T4	.53	6H6	.39	7Z4	.57	46	.62
2J26	6.95	5NP1	4.98	713A	.79	1624	.67	KC4		1T5GT	.69	6H6GT	.37	12A	.57	47	.69
2C21	12.75	5RP1	19.69	715AY	3.59	1625	.19	ML100	37.50	1T4	.59	6J5	.47	12AA6	.17	49	.85
2J30	49.50	6F4	5.59	715A	5.49	1626	.25	ML101	49.50	1V	.57	6J5GT	.39	12A7	.89	50	1.39
2J31	8.49	6J4	4.49	715B	6.59	1629	.19	MX408U	.39	2A3	.87	6J6	.77	12A8GT	.49	50A5	.69
2J32	12.95	7BP7	3.95	715C	19.95	1630	.49	RFL21	.39	2A4G	1.07	6J7	.67	12AH7GT	.80	50B5	.53
2J33	18.75	9GP7	8.95	717A	.49	1631	.98	RK59	1.69	2A5	.69	6J7GT	.67	12AT6	.44	50L6GT	.52
2J34	18.95	9JP1	6.95	721A	1.98	1632	.69	RK60	.42	2A6	.79	6K5GT	.79	12AT7	.79	50Y6	.57
2J36	97.50	9LP1	19.95	723A/B	12.95	1633	.79	RK65	24.50	2A7	.79	6K6GT	.44	12AU6	.57	52	.87
2J37	12.95	9LP7	1.98	723A/B	2.95	1634	.98	RK71	.59	2V3G	.69	6K7G	.49	12AU7	.66	56	.45
2J38	11.95	10BP4	19.69	725A	6.45	1635	1.09	RK73	.59	2X2	.37	6K8	.79	12AV6	.54	57	.45
2J39	19.95	10Y	.19	726A	6.75	1636	1.98	RX21	2.39	2X2A	.65	6L5GT	.79	12BA6	.58	58	.49
2J40	24.50	12HP7	14.95	726B	29.50	1638	.65	RX120	8.95	3A4	.34	6L6	1.05	12BE6	.49	59	.89
2J46	49.50	12GP7	12.75	726C	49.50	1644	.98	T20D	7.35	3A5	.79	6L6G	.99	12F8	.54	70L7	.99
2J48	12.75	12HP7	13.95	730A	9.95	1654	2.45	VCR138	5.95	3A8	1.59	6L6GA	.85	12F8GT	.58	71A	.59
2J49	39.50	12LP4	24.95	730TL	69.50	1665	1.10	VR53	.19	3B7/1291	.29	6L7	.79	12H6	.27	75	.53
2J50	22.50	15E	1.19	800	1.49	1851	.69	VR78	.29	3E29/1299	.79	6L7G	.87	12J5GT	.54	76	.44
2J54B	22.50	15R	.49	801A	.19	1960	.89	VT127A	2.19	3LF4	.79	6N7	.79	12J7GT	.67	77	.43
2J55	69.50	16AP4	49.50	802	4.19	2050	1.19	VT158	14.95	3Q4	.47	6Q7	.64	12K7GT	.52	78	.44
2J61	34.50	19T8	.89	803	2.95	2051	.39	WL111	.49	3Q5GT	.67	6R7	.79	12K8	.59	80	.37
2J62	34.50	20P1	.29	804	7.95	5003	4.75	WL531	5.95	3S4	.57	6S7G	.79	12Q7	.49	81	1.25
2K25	22.50	28D7	.29	805	3.65	5011	.25	WL530	12.75	3V4	.67	6S8GT	.77	12SA7	.57	82	.84
2K28	24.95	30P	.19	807	1.09	5012	1.39	WL532	4.75	5R4GY	1.09	6SA7	.44	12SC7	.54	83	.75
2K32	24.50	35TH	5.95	808	.89	5013	1.39	WL5582	1.98	5T4	.87	6SC7	.59	12SF5	.54	83V	1.39
3AP1	4.59	45BP	.19	809/3C30	1.89	5014	22.50	WL616	37.50	5U4G	.49	6SD7GT	.59	12SF7	.54	84/6Z4	.36
3B22	1.95	53A	5.95	810	7.95	5020	.89	WL619	18.95	5V4G	.49	6SF5	.49	12SG7	.52	85	.69
3B24	1.49	70TL	5.95	811	1.98	8025	3.69	WL677	34.50	5Y4G	.87	6SH7	.59	12SH7	.35	89Y	.35
3B25	4.87	100B	.97	812	2.45	9001	.32	WL681/		5W4	.67	6SG7	.59	12SJ7	.47	117L7/M7	1.19
3B26	1.49	100TH	9.95	813	6.86	9002	.25	5686	22.50	5X4G	.57	6SH7	.57	12SK7	.57	117N7	1.19
3B27	1.95	100TS	2.25	813	6.85	9003	.33	WL710A	.25	5Y3GT	.39	6SJ7	.47	12SL7	.59	117P7	1.19
3B28	7.95	211	.25	814	1.98	9004	.24	OA2	1.29	5Y4G	.49	6SK7GT	.44	12SN7	.52	117Z3	.49
3BP1	2.39	217C	9.95	815	1.59	9005	1.35	OA4G	.89	5Z3	.52	6SL7GT	.59	12SQ7	.49	117Z6	.65

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Precision 15 Meg. 1% Accuracy Resistor. Non-inductive. 1 watt, hermetically sealed in glass 25 ea. 10 for $1.90

Thermal Time Delay Relay. 15 to 3 seconds, plugs into 4 prong Tube Socket Glass Enclosed 250 V ..... .75

PRECISION 1% W.W. RESISTORS
Ohms: 2K, 2500, 5K, 8500, 85K, 750K ..... .25 ea.

OIL CONDENSERS

.02	mfd	440 vac	6.95	.5	mfd 2000 vdc—5.95
.2	mfd	600 vdc	.39	10	mfd 4000 vdc—6.95
.4	mfd	600 vdc	.59	.2	mfd 4000 vdc—4.95
.6	mfd	600 vdc	.79	1	mfd 5000 vdc—4.50
3.3	mfd	600 vdc	.79	1.1	mfd 7500 vdc—2.25
10	mfd	600 vdc	.89	.2	mfd 6000 vdc—9.95
.4	mfd	1000 vdc	.95	1	mfd 7500 vdc—9.25
.5	mfd	1000 vdc	1.39	.01/.01	mfd 12kv
10	mfd	1000 vdc	1.99		dc—5.75
.2	mfd	1500 vdc	1.25	.005/.01	mfd 12 kv
.4	mfd	1500 vdc	2.25		dc—5.50
.6	mfd	1500 vdc	2.95	.65	mfd 12,500 vdc—12.95
1	mfd	2000 vdc	1.65	.2	mfd 15 kv dc—49.55
.2	mfd	2000 vdc	2.25	1	mfd 15 kv dc—15.95

HIGH VOLTAGE VACUUM CONDENSER
50 MMF 32KV EIMAC VC 50-32 ..... 5.75
12 MMF 32 KV EIMAC VC 12-32 ..... 4.95

FILAMENT TRANSFORMERS
110 V 60 CY Pri. Cased.
5 Volt 15 Amp $2.75
2.5 Volt 10 Amp 3.49
2.5 Volt CT 21 Amps 4.75
5½V CT 21A, 7.5V 6A, 7.5V 6A 4.95
5 Volt 4A, 6.3V, 3A 2.45
2.5V CT 20A, 2.5V CT 20A 6.95

CHOKE BARGAINS
6 Henry 50 ma 300 ohms ..... 3 for $0.99
8 Henry 150 ma 140 ohms ..... .99
1.5 Henry 250 ma 72 ohms ..... .59
Swing 1.8/12 Henry 1 Amp/100 ma 15 ohms 19.95

HEAVY DUTY RHEOSTAT
25 Ohms, 8.75 Watts Max. with Knob and Hardware $3.95
10 for $29.50

FILAMENT TRANSFORMER
6.3 volts at 12 amps. Primary 110 volts 60 cy. Size 3¼"H x 2⅞"W x 3"D. WT 3½ lbs. As Illustrated. While they last ..... $1.69 ea.

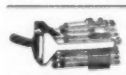
SENSITIVE RELAY
Breaks at 3 MA. Beautifully Constructed and delicately pivoted. Approx. 2000 ohms resistance. Housed in dustproof aluminum can. Plugs into 5 prong socket. Only ..... .99 ea.

PLUG IN CAPACITOR
8 x 8 Mfd 600 volts DC. Oil filled. Plugs into standard 4 prong socket. 3¼ h x 3½ w x 1⅞ d $1.39

GENERAL ELECTRIC Type PRC Instantaneous Overcurrent Relay. Adjustable from 100 to 200 MA. Electrical and Manual Reset. 4 PDT. Reset 110 Volts 60 Cycles $7.95

BAKELITE CASED MICA

MMF	VDC	Price	MMF	VDC	Price
D .001	600	$ .18	C .001	3 KV	.99
E .01	600	.26	C .002	3 KV	.95
D .02	600	.26	D .005	3 KV	.70
E .027	600	.26	C .005	3 KV	1.25
C .001	1 KV	.45	C .006	3 KV	1.50
C .056	1 KV	.50	D .002	3 KV	.70
C .07	1 KV	.55	C .0001	5 KV	.70
D .02	1200	.55	C .0005	5 KV	.85
C .024	1500	.65	C .0015	5 KV	1.60
C .033	1500	.75	C .003	5 KV	1.90
C .015	2 KV	.80	C .005	5 KV	2.50
C .02	2 KV	.90	C .002	6 KV	2.90
D .002	2500	.45	B .007	5 KV	2.75
E .005	2500	.55	B .0005	5 KV	2.90
C .025	2500	1.25	B .002	12 KV	6.50



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3 PDT, plus 6 PST 1.75

Heavy Duty Tap-Switch Ohmite Model 412
Single Pole 6 Positions. Non-Shorting 50 amp. contacts. Vitreous Enamel case. List $16.00 ..... Only $2.95

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High Current Plate Transformer 810 volts CT at 7.75 MA. Pri. 110/220 v. 50 cy. Wt. 38 lbs. Fully cased $6.95

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DEPARTMENT EA

Latest WELLS Tube Price List

Many Types Are Now Scarce At These Low Prices. Check your requirements at once for your own protection. All tubes are standard brand, new in original cartons, and guaranteed by Wells. Order directly from this ad or through your local Parts Jobber.

TYPE-	PRICE EA.
0A4G	.95
0A3	.45
E1-C1A	3.95
1A3	.60
1A5GT	.65
C1B, 3C31	4.85
1B4P	1.75
1B21A, G1471A	2.55
1B22	3.40
1B23	7.50
1B32, 532A	1.85
1B40	5.25
1B48	9.90
E1JC	4.85
1C5GT	.65
1C6	.75
1C7G	.85
1D8GT	.95
1E7GT	1.95
1F4	.90
1G5	.65
1H4G	.80
1H5G	.80
1I4	.50
1LC6	.75
1LN5	.85
1N5GT	.75
1P24	2.50
1Q5GT	.85
1R4	.55
1S5	.70
1T4	.75
2A3	1.05
2A7	.75
2AF1	4.75
2B7	.75
2B22, 5105B	3.25
2C22, 7193	.35
2C26	.90
2C26A	.40
2C34	.40
2C44	1.25
2J21	10.45
2J21A	11.45
2J22	9.85
2J26	8.45
2J27	12.95
2J31	9.95
2J32	12.85
2J33	18.95
2J34	17.50
2J37	13.95
2J38	9.95
2J48	12.95
2J51	24.50
2J52	14.95
2X2	.75
2Y3G	1.20
3A4	.95
3A4/67	.45
3B7	.45
3B22	2.35
3B24	1.75
3BP1	3.75
E1-3C	3.95
3C21	5.00
3C24, 24G	.50
3C31-C1B	4.85
3CP1-S1	1.95
3DP1	3.75
3D6/1299	.45
3EP7	1.85
3FP7A	4.95
3GP1	4.50
3H17	1.00
3HP7	2.95
3Q5	.90
3Q5GT	.90
3S4	.75
5A4	2.00
5E1S	14.95
VT5-2/5A	1.20
5AP1	3.95
E1-C5B	4.25
5BP1	2.75
5BP4	3.95
5CP1	3.75
5DP1	24.75
5FP7	2.75
5GP1	2.75
5HP4	4.75
5J23	14.25
5J29	13.45
5V4G	1.07
5W4	.76
5Z3	.80
5Z3G	.75
6-4	.35
6-7	.35
E1-C6A	2.00
6A3	.80
6A5	.65
6A8	.95
6AC7	.80
6AE6G	.85
6AG5	1.20
6AH6	1.10
6AK5	1.20
6AL5	.80
6AM5	.95
6AQ5	.81
6AU6	.95
6AV6	.81
6B4G	.95
6B7	.75
6B8	.95
6B8G	.95
6BA6	.95
6BE6	.95
6BF6	.95
6C4	.40
6C8G	1.05
6C21	19.25
6D6	.50
6F5	.85
6F6	.90
6F6G	.60
6F8G	.95
6G6G	.80
6H6	.45
6J6	.90
6J7GT	.70
6J8G	.95
6J8GT	.55
6K7	.80
6K7G	.80
6L6G	1.35
6L7	.75
6N7	.75
6N7GT	.75
6Q7	.55
6R7G	.75
6S7	.65
6SA7	.80
6SC7GT	.70
6SD7	.80
6SF5	.65
6SG7	.65
6SH7	.40
6SH7GT	.40
6SJ7	.90
6SJ7GT	.55
6SK7	.60
6SK7GT	.60
6SL7GT	.60
6SN7	.55
6SN7GT	.60
6SQ7	.60
6SQ7GT	.60
6SR7	.60
6T8	.95
6V6	.60
6V6GT	.75
6W6G	.95
6X5GT	.73
6Y6G	.95
7-7-11	.60
7A4, XXI	.60
7A5	.80
7A6	.75
7A7	.90
7B4	.90
7B6	.90
7B8	.90
7BP7	4.95
7C4, 1203A	.95
7C5	.65
7E5, 1201	.65
7F7	.90
7F8	.70
7H7	.70
7J7	.70
7N7	.70
7T7	.90
7Y4	.90
9-3	.45
10	.55
10 ACORN	.65
10 (VT-25A)	.55
10E, 146	1.00
10T1	.60
10Y (VT-25)	.45
12A5	.25
12A6GT	.25
12A7	.80
12A7GT	1.12
12AU7	.90
12AX7	1.20
12BD6	1.20
12C8	.50
12F8GT	.65
12H6	.40
12J5GT	.40
12J7GT	.70
12K8	.65
12Q7GT	.75
12R7	.75
12SA7	.75
12SC7	.75
12SF7	.60
12SG7	.65
12SH7	.40
12SJ7	.73
12SK7	.60
12SK7GT	.60
12SL7GT	.60
12SN7GT	1.10
12SQ7GT	.60
12SR7	.60
12X825-2AMP. TUNG.	1.95
12Z3	.90
13-4	.35
14A7	.90
14B6	.75
14F7	.90
14H7	.90
14Q7	.90
14R7	.90
15E	1.50
15Q	1.20
16X879-2AMP. TUNG.	1.95
7G17/9G7	3.25
19	1.20
20-4 BALLAST.	.45
21-2 BALLAST.	.45
RE121	2.75
23D4	.45
8324	1.75
24A	.75
8825, 802	2.85
VT-25-A, 10	.55
2525	.73
25Z6GT	.55
25Z6G	.55
25	.60
27	.50
28D7	.40
30 VT-67	.75
30 (NOT VT-67)	.75
31	.75
34	.35
6134	1.50
8834, 2C34	.45
35/51	.60
35L6GT	.73
35W4	.73
35Z5GT	.62
36	.40
37	.40
38	.40
38, 44	.35
41	.50
42	.50
43	.50
45 SPEC.	.50
46	.75
6950	.45
5B/50	1.00
50B5	1.00
50L6GT	.95
56	.65
57	.45
58	.50
8800/4641	.95
VT62 (BRITISH)	1.10
65	1.25
6984	.90
VT67/30	.90
70L7	1.05
71A	.75
CR072	1.50
CR072	.95
CY872	1.75
RR072	.90
RR073	1.25
75	.89
76	.55
77	.55
78	.80
VR78	.65
80	.45
FG-81-A	3.95
83V	.90
89	.73
89Y	.40
VR90	.65
VT90 (BRITISH)	2.55
VR92	.65
FG95/DG1295	9.95
VT98/RE15	14.95
100B	2.75
100TH	11.50
101/837	1.65
102F	3.55
5G105	9.75
VR105	.85
VT-111-S	.55
114B	1.20
121A	2.65
122A	2.95
VT127 (BRITISH)	.35
VT127A	2.95
VR150	.50
VT158 (UK)	14.95
FG172	19.75
205B	1.45
211 (VT-4-C)	.60
215A (VT5)	1.20
CRP220	2.00
221A	1.75
227A	4.75
231D	1.20
RX233A	1.95
250B	9.00
257A	3.00
258A	2.95
282B	4.25
287A/722A	9.50
304TH	1.75
304TG	5.75
307A	4.25
310A	.55
327A	2.50
350B	2.55
354C	14.95
356B	4.95
368AS, 703A	3.95
371A, VT62	.95
371B	.95
388A	3.95
393A	4.65
394A	4.95
400-500-BALLAST.	.30
417A	14.50
434A	3.40
446A	1.55
446B	1.55
450TH	17.95
G1451	1.90
G1471A	2.55
885011	3.00
707	9.95
W1530	8.00
W1531	12.95
W1532	1.85
532A, 1B32	3.55
G1859	3.75
W1610	7.45
W1615	1.05
W1632A	8.75
700	7.95
700B	7.95
700C	7.95
700D	7.95
701A	3.00
702A	2.95
703A, 368AS	3.95
704A	1.75
705A	1.65
706AY	17.50
707A	14.00
707B	15.00
708A	3.75
709A	4.75
710A	2.45
713A	1.50
714AY	3.75
715B	9.75
717A	.85
718BY	15.00
719EY	15.00
721A	3.75
721B	3.95
722A/287A	9.50
723AB	14.95
724A	4.25
725A	9.95
726A	12.50
726B	13.50
730A	9.95
801	.50
801A	.70
803	5.25
804	8.95
805	5.95
807	1.25
808	1.65
809	2.50
812	2.95
813	7.85
814	3.75
815	2.85
826	.75
830B	3.95
832A	7.95
834	5.75
835, 3B111A	1.10
836	1.35
837	1.65
838	3.25
841	.50
842	2.75
843	.50
851	39.00
852	8.25
861	29.45
864	.45
866	2.55
866-JUNIOR.	.85
866A	1.30
869	18.75
869B	27.25
872A	2.45
874	1.95
876	.50
878	1.95
878/2X2	.55
902	3.50
923 (PHOTO)	1.35
930	1.00
931A	3.95
954	.35
955	.55
956	.55
957	.45
958	.55
958A	.50
959	.88
95?, TG17	3.25
991, NE-16	.24
1005	.35
1007	4.50
1148	.36
1201	.45
1203	.68
1203A	.65
1294	.86
DG1295	9.95
1296, 3D6	.45
1613-SELECT. GE'S	.65
1616	1.25
1619	.35
1624	1.25
1625	.35
1626	.35
1629	.35
1630	3.95
1639	.90
1641/B&O	.65
1642	.80
1852, 6AC7	.90
1853, 6AB7	.85
1860	1.25
1861, 532A	1.85
2050	.78
2051	.75
CV666 3	1.20
7193	.35
8011, VT90, BRITISH	2.85
8012	3.25
8013	1.25
8013A	1.50
8019	1.75
8020	3.25
8025	0.75
9001	.65
9002	.45
9003	.60
9004	.40
9005	.40
3B111A/835	1.10

XTAL DIODES

1N21	.65
1N21A	.95
1N21B	1.20
1N22	.60
1N23	.60
1N23A	.65
1N27	.85
1N29	.85
1N51 (GE)	.75
1N48 (GE)	.75
1N52 (GE)	1.00

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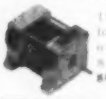
AC-SERVO MOTORS

Pioneer Type CK-2. 26 v. 400 cycles fixed phase, var. phase 49 v. max. 40:1 gear reduction. Stock #SA-97A. **Price $6.50 each.** Also available less gear train. **Price $4.25 each.** Stock #SA-97.

PIONEER CK-17

400 cycle 2 phase, 26 v. fixed phase, 45 v. max. variable phase. Built in gear reduction. Output shaft speed approx. 4 rpm. Stock #SA-237. **Price $12.50.**

FORD INS'T SERVO MOTOR



115 volt 60 cycle two phase low inertia motor. 15 watts output. HuOrd: 207927. Stock #SA-291. **Price $19.50 each.**

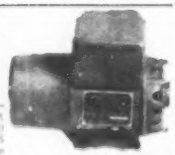
MINNEAPOLIS-HONEYWELL
Type G303AY2CA4

115 v. 400 cycles. Built in gear reduction. 50 in/lb. torque. Stock #SA-268. **Price $6.75 each.**

SAWTOOTH POTENTIOMETER
W.E. KS-15138

Type RL-II-R. 100 ohm element. Non linear ring gives linear output with CRT deflection coil load. Cont. rotation. 2 brushes 180 degrees opposed, 4 brushes 150 degrees opposed. Stock #SA-248. **Price $5.50 each.**

INVERTER SPECIALS
400 Cycles



Leland SD-93 — (19285) — Input 28 volts DC at 60 amps. Output 115 volts three phase 400 cycles at 750 va. 0.90 P.F. Second output voltage of 26 volts 400 cycles at 50 V.A. Voltage and frequency regulated. Designed for use with various autopilots. Stock #SA-209. **Price $79.50 each**

General Electric PE-218 D—Input 24 v. d-c @ 82 amps. Output 115 v. 400 cycles @ 1500 va. Power factor 0.90. Shipping wt. 160 lbs. New—Original cartons. Stock #SA-112. **Price $39.50 each.**

Leland or Russell PE-218 E or PE-20 SH similar to PE-218D. Stock #SA-112A. **Special Price $29.50 each.**

General Electric 5D21NJ3A — Input 24 volts DC at 36 amps. Output 115 volts 400 cycles, 435 V.A. at 0.90 P.F. Weight 55 lbs. Stock #SA-41. **Price $12.50 each**

General Electric 5AS13NJ3 — Input 24 volts DC at 100 amps. Output 115 volts 400 cycles 1500 V.A. 0.8 PF. Stock #SA-285. **Price $19.50 each.**

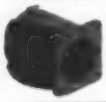
SERVO AMPLIFIER

Minneapolis Honeywell 115 v. 400 cycle unit. For use with SA-268. Model G402ATCA3. Designed for use with A-C error signal from bridge circuit. Stock #SA-269A. **Price $8.50.**

DC SERVO MOTORS

Elinco B-64 DC Servo Unit — armature voltage, 80 v d-c max. 27.5 v. field 1/165 hp 3100 rpm. Field current 200 ma. Armature current 200 ma. at normal torque. Stock #SA-211. **Price $12.50 each.**

John Oster A-21E-12R — Split field series reversible motor. W.E. KS-5996-L/O-4. 28 v. d-c at 0.4 amps. 2 watts output. 1⅛" diam. x 2½" lg. Ideal for relay or thyratron servos. Stock #SA-282. **Price $6.75 each.**



G.E. 5PS56HC18 — Split field series reversible motor. 60 v. d-c at 1.4 amperes. 5500 rpm. 3" diam. x 5" lg. Ideal for servo applications. Stock #SA-273. **Price $8.75 each.**

OSTER PM MOTOR
Alnico Field

27.5 v. d-c. Can also be used as rate generator. #SA-281. **$3.75 each**

MAGNETIC AMPLIFIER ASSEMBLY

Sperry 681824. Saturable reactor type output static former. Designed to supply one phase of 400 cycle servo motor. Stock #SA-266. **Price $6.75 each.**

PIONEER TORQUE UNITS

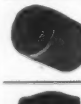
Types:
12602-1-A
12604-3-A
12606-1-A
12627-1-A, 12627-7-A

Prices On Request

Blower Assembly
MX-215 APG

John Oster C-2P-1L, 28 V. DC, 7000 RPM 1/100 H.P. #2 L-R Blower. Stock #SA-202. **Price $4.75 each**

AC Motor Special
Eastern Air Devices J-33
115 v. 400 cy. 2 phase synchronous. 4000 RPM. Stock #SA-258. **Price $8.00 each**



Compass Indicator
I-82F Compass Indicator. 0-360° 5 in. dial, 26 v 400 cy. 8.15 v. 60 cy. Ideal position indicator. Stock #SA-284. **Price $6.50 each**

LP-21-LM Compass Loops

New

Motor driven loop enclosed in graphited zeppelin housing. Includes Autosyn transmitter. **$12.50 each**

G.E. Servo Amplifier—2CV1C1 Aircraft amplidyne control amplifier. 115 volt 400 cycles. Two channel. Uses 2 6SN7GT and 4 6V6GT tubes. Supplied less tubes. Stock #SA-168. **Price $9.50 each.**

1SF SYNCHRO SPECIAL

Navy Ordnance Type 1F Special. Designed for 115 volt 400 cycles operation. Use as either generator or repeater. May be used on 24-28 volts 60 cycles operation. Stock #SA 29. **Price $19.50 each.**

SYNCHROS

Navy Types

1G, 1F, 1CT, 5G, 5F, 5CT, 5DG, 5HCT, 5SF, 5HSF, 5SDG, 6DG, 6G, 6DG, 7G, etc.

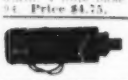
Prices on Request

D.C. MOTORS

Universal Electric DC W.E. KS-5603-1-02, 28 v. d-c 0.6 amps. 1/100 hp. 4 lead shunt. Stock #SA-233. **Price $2.95 ea. plus 15¢ p.p.**

12 V.D.C. Motor
John Oster B-9-2
1.4 amps.
5600 rpm.
1⅛" Diam. x 3¾" Lg. Spline shaft. C.W. rotation. Stock #SA-46. **Price $1.95 each**

DELCO CONSTANT SPEED MOTOR A-7155
1/26 hp. 27.5 v. d-c 3600 rpm. Cont. duty. 2¾ diam. x 5⅛" lg. ¾" shaft extension. 5/32" diam. 4 hole base mounting. Stock #SA-94. **Price $4.75.**



Delco 5069225 Constant Speed DC Motor. 27 v. d-c 120 rpm. Governor controlled. Stock #SA-249. **Price $3.95 each.**

General Electric 2 RPM Motor. Type 5BA10FJ378 — 27 v. d-c @ 0.6 amps. 10 inch torque at 2 rpm. Shunt wound. D-C noise filter. Stock #SA-274. **Price $6.75 each.**

Synchron 10 RPM Timing Motor—24 V. Hanson Mfg. Co. Stock #SA-110. **Price $3.75 each.**

General Electric Type 5BA10AJ52C. 145 rpm. 27.5 volt D-C motor. 0.65 amps. 14 in.-oz. torque. Shunt wound four lead reversible. Stock #SA-218. **Price $4.75 each.**

D-C ALNICO FIELD MOTORS

Delco 5069456. 27.5 volts. 10,000 rpm. 3" x 17 x 27 lg. Stock #SA-236. **Price $6.75 each.**

Other models also available

Prices F.O.B. Paterson
Phone ARmory 4-3366
Teletype PAT. 199

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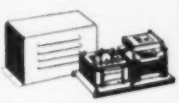
Servo-Tek products co.
4 Godwin Ave. Paterson, N. J.

SPECIALISTS IN FRACTIONAL HORSE POWER MOTOR SPEED CONTROL

LINE VOLTAGE STABILIZERS

RAYTHEON—Navy Type, CRP-201407. Input: 92-138V., 57/63 CPS., 1 PH. Output: 115V., 0.92 KVA., 1% Reg., 0.96 PF. Weight 385 lbs. Overall size—36" high x 20" wide x 12¼" deep. Enclosed in Navy Grey Ventilated Cabinet for Wall Mounting.
Brand New $69.50



RAYTHEON Adj. input tape 95-130V., 60 cy., 1 Ph. Output: 115V., 60 Watts. ¾ of 1% Reg. Wt. 20 lbs. 6⅛" H x 5⅛" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized.
Special $12.50

TRANSFORMERS

1. 5 KVA Stepdown
General Electric Cat. No. 76G173. Input: 115 or 230 Volts, 60 cycles. Output: 23 or 11.5 volts at 1.5KVA. Either high voltage connection may be used with either low voltage connection. Weight 50 lbs.
Brand new $23.95

FILAMENT TRANSFORMER

Raytheon Hypersil core. Primary: 115V., 60 cycles. Sec: 6.3 at 22A., 6.3 @ 2.4A., 6.3 @ 2.25A., 6.3 at 0.6A., 1700V. INS.
Brand New $3.95

For type 866 tubes

Kenyon. Input: 115 volts. Output: 2.5 volts, center tapped, at 10 amps. Glazed porcelain standoff insulated for high voltage breakdown.
Brand New **$2.95**

AUTO TRANSFORMER

G.E. 400 cy. Cat. No. 80G184 K.V.A. 9458—520P Volts 460/345/230/115. New..... $3.45

FILAMENT TRANS. 400/2600 cy.

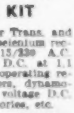
Input: 0/75/80/85/105/115/125V. Output: 5VIA, 5V3A, 5V3A, 5V3A, 5V6A, 6.3V5A, 6.3V5A
$1.95

THYRATRON POWER TRANS.

Raytheon UX8876. 400/1600 cy. PRI: 115V, 1 PH SEC: 50-050V at 0.5A, 6.3V 1.2A Test r.m.s. 1780
$2.75

PULSE TRANSFORMER

Utah No. 9350 ..... $1.25



BLOCKING OSC. TRANS.

Westinghouse #122 AWP Fosterized
$4.95

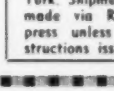
12 and 24 Volt POWER KIT

Consists of Power Trans. and full wave bridge selenium rectifier. Input: 115/230 A.C. Output: 12/24V D.C. at 1.1 amps. Fine for operating relays, small motors, dynamotors, or for low voltage D.C. source in laboratories, etc.
Brand New **$7.95**

SWEEP GENERATOR CAPACITOR

High speed ball bearings. Split stator silver plated coaxial type. 5/10 mmfd. Brand new.
$1.00

Differential Synchros

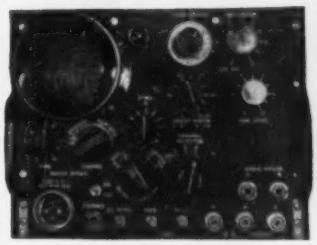


90/90 volts, 400 cycles. Brand new in sealed containers. Ford Inst. Co. type 5SDG. Brand new. **$12.50**

MICROWAVE RECEIVERS APR. 1, APR-4, APR-5A.

Tuning Units for APR-1 or APR-4. TN-16 (38-95 mc). TN-17 (74-320 mc.) TN-18 (300-1000mc.) These front ends may be used with any 30 mc IF amplifier or as converters into receivers tuned to 30 mc.)

MODEL AN/APA-10 PANORAMIC ADAPTER



Provides 4 Types of Presentation:
(1) Panoramic (2) Aural
(3) Oscillographic (4) Oscilloscopic
Designed for use with receiving equipment AN/ARR-7, AN/APR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 453kc, 2.2mc or 30mc. With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.
Includes 60 page T. M $195.00

RADIO MODULATOR

Type BC-423-B, or tweeter, is a miniature keying unit, modulator and transmitter combined. A dipole mounted atop the tweeter case radiates a signal pulse at 205 megacycles modulated by pulses occurring at 4,098 CPS. Uses 2-6J7, 1-6F6, 1-935, 1-5W4 tubes. Operates from 115V. 60 cy. source. Brand new including tubes and instruction book.. **$19.50**

PARABOLOIDS

Spun Magnesium dishes 17⅛" dia., 4" deep. Mounting brackets for elevation and azimuth control on rear. 1⅛" x 1⅝" opening in center for dipole. **Brand new per pair** **$8.75**

MOTOR GENERATORS

Allis-Chalmers 115V. D.C. to 120V, 60 cy. 1 Ph. 1.25 K.V.A., P.F. .80 Centrifugal starter. Fully enclosed.
New $97.50

Same as above but for 230V. D.C. Input $125.00

Spare Parts Kit for either machine..... **$15.00**

Diehl 120V. D.C. to 120V. A.C., 60 cy., 1 Ph., 2.5 K.V.A., P.F. 4. Complete with magnetic controller, 2 field rheostats and full set of spare parts including spare armatures for generator and motor.
New $185.00

O'Keefe and Merritt, 115V. D.C. to 120V. A.C. 50 cycles, 2 K. V. A., Pf. .9 Idles as a 3 phase synchronous motor on 208V, 50 cy.
New $165.00

Electrolux dynamotor 105/130V. D. C. at 6 amps. to 26 or 12V. D.C. at 20 amps or 40 amps. respectively. Fully filtered for radio use and complete with Square "D" Unswitch. Navy type CAJO-211444.
New $74.50

Shown above are selections from our inventory. A complete listing is now available. *Write for it today.*

MERCURY CONTACT VACUUM RELAYS

WE Type D-168479

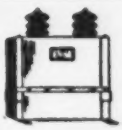
Glass sealed, mercury-wetted contact switches surrounded by operating coils encased in metal housings on octal tube base. 2 P.D.T. contacts. 2 coils, 700 and 3300 ohms. Operating current coils serieced 6.6 MA releasing at 5.8MA. Operating life 1000 hrs. at 60 operations per sec. Used for: High Speed Keying • Tabulating • Sorting and computing machines • Relay amplifiers • Vibrator supplies • Servo Mechanisms, etc.
$4.75 ea.
Brand New
Send for 4 page data sheet

THERMOSTATIC TIME DELAY RELAY

Amperite type 115 No.—45 Heater voltage 115V. Normally open SPST contacts. 45 sec. delay. Contact rating 115V 3A., A.C. (or 440V., A.C. 2A) max. voltage on contacts—1000 max voltage bet. contacts and heater—1500. Size 3 9/32 x 1¾" overall. Made for U. S. Navy..... **$1.10**

CRYSTAL DIODE

Sylvania 1N21B. Individually boxed and packed in loaded foil. Brand new **$1.00**



High Voltage Capacitors Oil Filled

.25 MFD., 20KV	$15.75
.5 MFD., 25KV	$23.50
1 MFD., 15KV	$16.50
1MFD., 7.5KV	$4.95

All brand new. Made by prominent manufacturers.

LAVOIE FREQ. METER MICRO-WAVE

375 to 725 MCS

Model TS-127/U is a compact, self-contained, precision (± 1 MC) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0-15 minute time switch. Contains sturdily constructed HI-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, L66 and 384 Tubes. Complete, new with inst. book **$49.50**
Write for descriptive circular.....

LINEAR SAWTOOTH POTENTIOMETER

No. KS 15138

Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output. Size approximately 3¾" dia. x 3" deep x 4¾" long. Enclosed in die cast alum. frame with AN connector socket.
$5.50
Brand New

U. S. NAVY SOUND POWERED BATTLE PHONES

Western Electric No. D173312, Type O, Combination headset and chest microphone as illustrated. Brand new including 20 ft. of rubber covered cable **$17.50**

Automatic Elec. Co. No. GL643AO. Similar to above but including Throat microphone in addition to chest microphone. Brand new with 20 ft. rubber covered cable **$13.50**

SYNCHRO GENERATORS

Brand new—Gov't. sealed and inspected—Packed in overseas cans. Synchro Transmitters 115V., 60 cy. operation. Precision accuracy made for gun fire control. Cost Gov't. $90.00 each. Wgt. 5 lbs. Dimensions: 4⅛"L x 3⅛".
Brand New Per Pair $14.75

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LECTRONIC RESEARCH TUBE SPECIALS

STANDARD BRANDS ONLY

RECEIVING TUBES			
0Z4G	59	6C4	21
1A3	45	6F8	69
1AB5	73	6H6	69
1B3GT/ 8016	1 18	6J5	49
1L4	66	6J5GT	59
1R4	29	6K6GT	52
1R5	69	6K7	54
1S4	56	6K8	65
1S5	64	6L6	1 22
1T4	64	6L6G	1 11
2X2 879	49	6L6GA	87
2X2A	79	6N8PT	79
3A4	61	6SC7	66
3A5	86	6SF7	72
3AQ5	1 74	6SG7	69
3B7 1291	29	6SH7	64
3D6 1299	29	6SJ7	59
3Q5GT	79	6SL7GT	69
3S4	61	6SN7GT	64
5R4GY	1 05	6SN7W	1 45
5T4	89	6V6	1 07
5U4G	59	6V6GT	59
5V4G	54	6W6GT	65
9Z3	65	6X4	59
6AB7 1853	99	6X5GT	59
6AC7 1852	79	7F7	79
6AC7W	1 45	7N7	79
6AG5	89	10Y	19
6AG7	1 19	12A6	24
6AJ5	89	12AH7GT	82
6AK5	89	12AT6	59
WE-6AK5	1 35	12AT7	99
6AK6	82	12AU6	72
6AL5	49	12AU7	86
6AQ5	72	12AX7	86
6AQ6	65	12BA6	64
6AS7G	4 22	12BA7	86
6AT6	54	12BE6	64
6AU6	72	12C8	59
6AV6	55	12SG7	69
6BA6	65	12SH7	69
6BA7	86	12SJ7	69
6BE6	65	12SK7	59
6BG6G	1 72	12SL7GT	69
12SN7GT	79
12SR7	69
28D7	61

Cathode Ray Tubes	
2AP1	3 65
2AP5	5 95
3AP1	6 65
3AP4	
906P4	5 94
3BP1	2 59
3CP1	1 87
3DP1A	5 75
5BP1	2 92
10HP7	6 91
14AP10	5 35
5AP1	3 75
5AP4	6 75
5BP1	2 48
5CP1	2 87
5CP7	3 76
5FP7	57
5HP4	3 35
5JP4	9 55
5LP1	15 95
5MP1	10 65
7BP1	12 87
7HP7	4 95
7HP14	14 95
9CP7	9 65
9LP7	5 55
10BP4	24 66
10FP4	20 55
12DP7	12 85
12GP7	12 85
905	4 47
913	6 90

Photo Cells	
1P24	29
918	58
927	1 67
931A	3 22
1645	1 67

Thyratrons	
OA4G	95
RL-C1A	3 35
2AG4	1 15
2D21	1 09
3C23	5 20
4C35	19 77
RL-C5B	8 95
C6J	4 44
FG-17	2 89
FG-33	11 95
FG-67	
1904	8 85
FG-81A	4 95
FG-105	9 95
FG-172	16 50
WE355A	14 15
394A	3 77
KU-610	6 35
KU-634	17 20
WL-677	24 00
873	6 95
884	1 35
885	88
1005	87
1904	8 85
2050	85
2051	49

Transmitting & Special Purpose Tubes	
OA2	1 52
OB2	1 75
1B22	3 87
1B23	8 95
1B24	4 90
1B26	4 50
1B27	6 50
1B29	2 90
1B32	3 15
1B36	5 50
1B42	9 50
1H29	58
2D22	1 45
2C22	22
2C26	27
2C34	28
2C44	79
2P22	1 25
2J21A	8 95
2J22	8 95
2J26	7 89
2J27	13 70
2J31	9 60
2J32	14 45
2J33	19 90
2J34	19 90
2J37	13 70
2J38	12 70
2J48	14 95
2J61	36 20
2K23	23 95
2X2 879	49
2X2A	79
3B22 EL-1	
4A1	58
4B22 EL-1	
5B	5 20
4B24 EL-1	
5C	2 64
4B25 EL-1	
6F	8 70
4C28	8 85
4B27	12 75
5D21	26 50
5J23	14 20
5J29	14 20
5R4GY	1 05
6C21	19 95
6J4	5 20
10T1	58
10Y	19
12A4	1 25
15R	75
REL-21	3 25
24G	44

RK-25	2 11
FG-32	4 25
RK-34	28
REL-36	76
RK-47	6 92
KF-50	45
VT-52	36
53A	3 52
RK-59	2 44
RK-60 1641	59
RK-72	92
RK-73	92
VR-75	98
75T	3 80
WE-78	34
VR-90 OB3	81
VT-98	
(BR)	29 90
C100E	2 30
100R	2 90
100TH	10 25
WE-101D	1 65
WE-101F	3 62
VR-105	
OC3	72
WE-113A	1 32
WE-124A	3 80
VT-127A	2 40
VR-150	
OD3	65
203A	6 40
203B	4 33
204A	27 90
WE-205B	1 70
CR-206	3 15
211	62
WE-215A	24
221A	1 95
227A	2 40
WE-231D	1 25
WE-245A	1 35
WE-249C	1 88
WE-252A	2 77
WE-259A	4 22
WE-271A	6 75
WE-283A	1 27
304TH	3 86

304TL	1 25
WE-310A	7 50
316A	66
350A	2 80
350B	1 95
354C	19 50
WE-356B	4 65
361A	4 75
371B	82
388A	2 95
417A	10 65
434A	3 65
446A	79
450TH	19 70
451	1 75
471A	2 75
503AX	1 47
504AX	1 47
507AX	1 47
527	9 75
530	17 20
531	17 80
532A	3 15
550	1 41
561	1 45
579B	5 85
HY615	29
631-P1	3 77
WL-670A	8 70
700B	16 90
700C	16 90
700D	16 90
701A	3 67
702A	2 95
702B	3 87
703A	3 90
704A	2 75
705A	1 17
706AY	45 00
706BY	45 00
706CY	17 95
706FY	45 00
707A	5 22
708A	6 95
708A	4 85
710A	2 25
713A	1 45

714AY	6 95
715A	6 75
715B	9 95
717A	97
721A	3 93
723A/B	16 50
724A	3 22
724B	3 22
725A	8 95
726A	14 50
730A	10 95
731A	2 45
WL-787	9 80
800	1 88
801A	1 75
802	4 25
803	6 87
804	8 95
805	4 75
807	1 15
808	2 19
809	2 60
810	7 25
811	1 91
813	6 95
814	3 79
815	1 72
816	97
822	57
829B	6 20
830B	3 35
832	4 91
832A	4 91
836	59
837	1 38
838	2 95
841	49
843	59
851	27 50
852	6 40
860	4 50
861	17 70
866	1 95
866A	95
869B	27 00
872A	1 88

874	1 65
876	39
878	1 88
954	39
955	39
956	49
957	49
958A	49
991	29
1005	24
1201A 7B5	29
1203 7C4	19
1294 1R4	29
1299 3D6	29
	66
1613	61
1616	87
1619	19
1624	69
1625	19
1626	29
1629	29
1630	3 11
1631	1 38
1636	3 77
1638	79
1641 RK-60	59
	39
1642	1 17
1960	1 21
UX-6653	65
7193	22
8005	4 65
8011	87
8012	1 45
8012A	1 91
8013	92
8013A	1 42
8014A	21 50
8016	1 18
8020	1 39
8025	3 17
8032	42
8042	39
8053	39
9001	29
9003	39
9004	39
9006	29

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MOLDED OIL-IMPREGNATED PAPER

.02 MFD	200 VDC	.04	Ea. $3.00 per 100
.05	200	.06	3.00
.1	200	.04 ½	3.00
.25	200	.06	4.00
.5	200	.09	4.00
.005	600	.04 ½	3.00
.01	600	.07	4.75
.05	600	.08	5.50

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ALL HIGH VOLTAGE INSULATION

13 H	250 MA	GEN. ELEC.	$3.22
10 H	400 MA	ACME	3.77
15 H	500 MA	AMERTRAN	9.28
14.4 7 H	130 570 MA	AMERTRAN	9.85
22 8 H	50 560 MA	AMERTRAN	15.25
.02 H	5 AMP	RCA	3.95

TEST EQUIPMENT

- Alfred W. Barber Labs. Mod. VM-25 VTVM $85.00
- General Radio Model P-500A Standard Signal Generator (Same as G. R. 805A except covers 9KC to 32 MC) $450.00
- Galvin Model CES-1 Standard Crystal Test Set $45.00

TS-10A APN Delay Line Test Set $25.00
TS-19 APG-5 Calibrator $75.00
AT-48 UP "X" Band Horn $3.95
REL W-1158 Frequency Meter 180-220 MC $32.95
CWI-60AAG Range Calibrator for ASB, ASE, ASV and ACYC Radars $398.95
CRV-14AAS Phantom Antenna for Transmitters up to 400 MC $11.75

- Raytheon VR-5 Constant Voltage Transformer Input 95/130 V 60 cy—Output 115 V 500 W $38.50

Sola Constant Voltage Transformer Input 95/125 V 60 cy—Output 115 V 285 VA $24.70
Federal Constant Voltage Transformer Input 95/115 V 50/60 cy—Output 115 V 210 W $34.00

- C.D Quietone Filter Type IF-16 110/220 V AC DC 20 Amps $9.00

All Items New Except Where Noted. • (Exc. Used Condition)

PULSE TRANSFORMERS

UTAH 9262	$1 50
UTAH 9278	$1 50
G. R. 686-627	$3 75
AN APN-9 981756-501	$1 25
AN APN-9 981756-502	$1 25
AN APN-4 Block Osc	88

RADIATION COUNTER TUBES

1B98 GAMMA COUNTER	$9.87
AMPEREX 75NB (Beta & Gamma)	$9.90

Full Line of Amperex Radiation Counters in Stock

115 V 60 CY AC RELAYS

Westinghouse Type SG—DPST Normally Open 12 Amp Contacts $1.88
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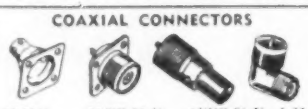


83-1AC	42	UG-12 U	63	UG-86 U	1 22
83-1AP	89	UG-21U	67	UG-87 U	68
83-1F	1 12	UG-22U	86	UG-171 U	1 35
83-1H	10	UG-23U	63	UG-175 U	15
83-1J	80	UG-24U	67	UG-176 U	15
83-1R	28	UG-27U	68	UG-180A U3	52
83-1SP	28	UG-29U	83	UG-191 AP	87
83-1SPN	28	UG-30U	94	MX-195 U	41
83-1T	1 12	UG-34 U	12	50 UG-197 U	1 33
83-22AP	85	UG-35 U	12	50 UG-206 U	58
83-22F	88	UG-37 U	12	50 UG-255 U	82
83-22R	48	UG-58 U	57	UG-264 U	1 74
83-22SP	60	UG-83 U	63	MX-367 U	15

Full Line of JAN Approved Coaxial Connectors in Stock. Send us your inquiries.

TYPE "J" POTENTIOMETERS

38c each

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
100	SS	10K	SS	50K	SS
200	SS	15K	"	100K	5.8"
500	"	15K	SS	100K	SS
650	"	20K	SS	150K	"
1000	SS	25K	1.7"	200K	SS
2500	SS	25K	SS	250K	SS
10K	3.8"	30K	1.1.8"	1 MEG	SS
10K	"	50K	5.8"		

Triple 100k - 3.8" Shaft - 1.47
All shafts ½ diameter except bushing - SS (screw slot)

UNIVERSAL OUTPUT TRANSFORMER

RCA 15 WATT HIGH FIDELITY

PRI—1000/2000/4000/8000/16000 Ohms
SEC—2.6/15 Ohms
$1.69 Each — $1.52 Ea. Lots of 10

IGNITRONS

GL-415/5550	$22.00
WL-681/5550	$22.00
WL-682/5551	$38.00

ROTARY CONVERTER

Janette Type CA-18 F with Filter Assy. Input—115 VDC. Output—110 V 60 cy 1.17A with spare brushes and brush-holders $28.80

PIONEER SERVO SYSTEM UNITS

- Type 12071-1A Torque Amplifier. Input 115 V 100 cy. Complete with Tubes $14.95
- Magnetic Amplifier Assy. Saturable Reactor Type to supply one phase of 400 cycle Servo Motor.... $5.95

OIL-FILLED CAPACITORS

50 MFD	220 VAC	$2 95
60 MFD	330 VAC	$4 89
32 MFD	2500 VDC	$10 50
7 MFD	660 VAC	$2 95
3 5 5 MFD	1000 VDC	95
1 MFD	7000 VDC	$1 79
.045 MFD	16 KVDC	$4 70

SPECIAL
2 MFD 12, 500 VDC
INERTEEN TYPE FP
$23.95

SELENIUM RECTIFIERS

HALF-WAVE	130 VDC OUTPUT	
25 MA — 58	150 MA — 91	250 MA — 1 21
100 MA — 72		400 MA — 1 51

SOUND POWERED TELEPHONES

- U. S. INSTRUMENT Type A-260
- WESTERN ELECTRIC Type D-173013
- AUTOMATIC ELECTRIC Type GL-832BAO

U. S. NAVY TYPE M HEAD AND CHEST SETS

These are high quality heavy duty units not to be confused with cheaper units now available. Designed to withstand exacting shock, vibration, salt water corrosion, temperature and pressure tests. ANY TYPE $14.88 ea. $28.00 per pair

SURPLUS EQUIPMENT TROUBLE SHOOTING MANUALS

(Includes Schematics)

BC-348 J, N, Q — SCR-522 — $1.00 Each
BC-779 — BC-610

KOLLSMAN INSTRUMENT

Freq. Cycles	100	Res.—Phase 1	300Ω
Volts—Phase 1	85	Res.—Phase 2	770Ω
Volts—Phase 2	68	No. of Poles	4
Current—Phase 1—110MA		Speed—RPM	2650
Current—Phase 2—40MA		Weight—Oz.	6 5
Input Watts—No Load 2650 RPM CW			5 8
Input Watts—Stalled			5 9
Torque Stalled—Oz. In.			80
Temp. Rise (°C)—2650 RPM—No Load			54
Temp. Rise (°C)—Stalled			54
Reversing Time—Seconds			0 1
Moment of Inertia (G. CM.²)			6 7

Will Operate Satisfactorily at 60 Cycles
Original Price $34.50—Our Price—$8.22 ea.
$7.50 EACH—Lots of 10

SPECIAL! 1N34 GERMANIUM DIODES **69¢**

LECTRONIC RESEARCH LABORATORIES

1021-23 CALLOWHILL ST. PHILA. 23, PA.

Telephones - MARKET 7-6590 and 6591

ORDER from ARROW!

TEN TUBE SUPERHET RECEIVER

with crystal controlled local oscillator. Has provisions for six crystal channels between 108 to 112 MCPS complete with tubes and crystals but less dynamotor.

New $7.95
Like New 5.95
Less Tubes and dynamotor but New 3.95

RECEIVER—Easily Converted for Use in Citizens Band Crystal Controlled Local Oscillator. Broad Band pass—20.7 MC IF's. Complete with 7-6AJ5, 1—12SR7, 2—12SN7, 1—28D7, relays, crystals. Schematic furnished. **New $7.95**

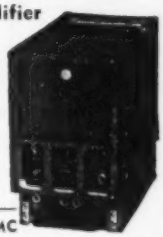
Westinghouse Auxiliary Relay Type MC

Style 423296 C—110 V 60 cycle 4 pole. Enclosed in glass case.....New $7.50

HERMETICALLY SEALED CHOKES

10 H. 100 M.A. 59c
3.7 H. 145 M.A. ..... 59¢
59 H. 100 M.A. 95c
10 H. 20 M.A. ..... 39¢
5x 5x1x1 H—4 winding layer wound. 5 H at 3.56 A 140 ohms 1 H at 1.56 A 320 ohms **New $6.49**

BC-605 Interphone Amplifier



Easily converted to an ideal intercommunication set for office — home — or factory.

Original—New..... $4.95
Like New..... 3.95

(With Schematic)

All necessary parts and instructions to convert the above to AC operation with one remote station $8.25 additional.

BC-604 Transmitter FM 20-28 MC

11 and 15 meters. Can be operated on 10 meters—10 channel push button crystal. With all tubes and meter but less dynamotor. Excellent Condition..... $12.95

Crystals—Set of 80..... 14.95
BC-603—Companion receiver to above with tubes but less dynamotor. **Used $17.50**

TUBES Drastically Reduced from 10 to 50%— Nationally Advertised Brands

Type	Net Price	Type	Net Price	Type	Net Price	Type	Net Price	Type	Net Price
1A4P	$0.24	5FP7	.95	7C4 1203A	.24	36	.24	837	1.49
1A6	.19	5J23	5.95	7S8/1201	.39	394TL	1.29	841	.29
1B85 /5S	.24	5T4	.49	10EY/T28A	.19	32L7GT	.39	864	.29
1B22	1.49	5W4	.49	12A6	.34	53	.24	872A	.98
1B26	2.29	5Z4	.49	12A6GT	.34	34	.24	954	.19
1B29	.24	6AB7	.59	12A7	.34	35/51	.24	955	.34
1B32-532A	2.79	6AJ5	.89	12AH6GT	.19	36	.24	957	.34
1C6	.19	6B8	.89	12F5GT	.29	37	.24	1625	.19
1C7G	.19	6C4	.29	12H6	.29	38	.24	1626	.24
1D5GP	.24	6D8G	.59	12J5GT	.24	39/44	.24	1629	.24
1D7G	.19	6F5GT	.39	12J7GT	.24	49	.39	1630	.29
1F4	.24	6F6G	.59	12K8GT	.24	50	.39	1636	2.95
1F5G	.24	6H6	.29	12Q7GT	.24	56	.24	1638	.69
1H4G	.24	6J7GT	.39	12SF5	.24	57	.24	1642	.29
1J6G	.24	6K6G	.59	12SF5GT	.24	70	.24	2050	.89
1J6GT	.24	6L5G	.39	12SP7	.24	77	.24	2051	.49
1P5GT	.24	6L7G	.39	12SH7	.24	211 Vt41	.29	7193	.19
1V	.24	6R7	.34	12SR7	.24	310A	.34	9002	.34
2A6	.39	6SF5GT	.34	12SR7GT	.29	371B	.34	9003	.39
2A7	.24	6S7G	.39	12SN7GT	.59	700A	7.95	9006	.29
2C26A	.19	6S8GT	.59	12Z3	.29	703A	4.49	GL4A21	.29
2V3G	.49	6SG7	.59	15R	.19	705A	.79	Amperite	
2X2/879	.25	6SH7	.39	19	.59	714AY	5.95	10T1	.29
3FP7	.98	6SJ7	.69			724B	4.95	Jan CRP72	.98
4AP10	.98	6T7G	.49	2J32	.24	801A	.39	REL36	.69
5BP4	2.95	6U7G	.29	28D7	.34	813	5.95	VR150	.39
5CP1	2.98	6Z7G	.39	30SP8C (Vt67)	.59	829	6.95	VR105	.69
5D21	9.95	6ZY5G	.79			832	4.95		

WRITE FOR QUANTITY PRICES

Miscellaneous SPECIALS

	Used	New
ID 6 APN 4 Scope, Excellent	$29.50	——
R 7APS 2 Receiver-Indicator	——	$79.50
R 78/APS-15 Receiver-Indicator	34.50	——
BC 1287 A Scope	75.00	——
ASB 7 Indicator Scope	12.95	——
SCR 522 Transceiver 100 to 150 MC	34.95	75.00
BC 1206 Receiver, 200 to 400 KC	3.95	5.95
MN 26 C or Y Receiver	17.50	24.95
RA 10 DA Receiver	17.50	24.95
T26/APT2 Transmitter	8.95	——
RT2/APN1 Transceiver	5.95	9.95
APN 1 Complete	——	24.50
BD 71 6 Pos. Switch-board	9.95	12.95
EE 8 Field Phones	7.95	——
BC 347 Interphone Amplifier	——	2.95
I-79 Tuning Meter	——	.89
AM 61 Indicating Amplifier	——	9.50
SCR 625 Mine Detector	——	39.50
PE 237 Power Supply	——	12.95
BC 461 Veeder Root Counter	——	.59
BC 442 Less Condenser	1.49	1.95
A 27 Phantom Antenna	——	.98
APS 13 UHF Antenna, Pair	——	.98
Manual for BC 312A/342J	——	1.00
Manual for SCR 269 G	——	2.50

Information and Prices on Request

BC 639 Receiver with RA 42 Rectifier
RTA 1B Transceiver
TA 21 Transmitter and MP 10G Power Jack
SCR 269 Compass Installation
R 5 ARN 7 Compass Installation
MN 26 Compass Installation
I. L. S. Installation (R 89-BC733)

	Used	New
FL 8 Filter	2.95	——
I-97 Bias Meter	4.95	3.95
RM 29 Remote Telephone Control	7.95	9.95
BC 602 Control Box	——	.98
One Tube Interphone Amplifier — Small compact aluminum case fully enclosed 2¼"x2¾"x5¾". Less Tubes	——	.79
BC 717 Transmitter, New but less Tubes	——	$4.50.
9043 Complete Autotune assembly with motor and frame as used in **ARC-1 Transmitter**	——	New 35.00
BC 709 Battery operated lightweight interphone amplifier. Complete with tube and shock mount, but less battery	——	New 3.95
SCR 183 Complete	——	New 49.50
Motor—Universal Electric, 24 VDC, will also operate on 24 VAC Diameter 1¾", Length 2-9/16", Shaft ¼" x ⅜"	——	New 1.49
BC-746 Bantam one watt foundation (See QST Jan. 1948). Contains 2 crystals, coil, tuning condensers, etc. Numbers 1-7-10-11-12-13-76. Each	——	0.95
BC-1291 Control box contains motor rheostat control rated 10 ohms at 3.88 amps. Brand new with cord and plug-in ventilated, mounted case	——	1.95
MC-385A Headset Adapter	——	New .49

DYNAMOTORS

DM-28—For BC-348 with Mount and Filter ..... New $6.95
Used 3.95
DY-12—For ART-13 less filter and base ..... New 6.95
DM-39 ..... Used .95
New 1.95
BD-77 ..... New 5.95
PE-206 ..... New 6.95
Used 2.75
PE-101 ..... New 2.75
PE-73 ..... New 3.95
DM-32 ..... New 3.95
Used .95 (3 for $2.00)
DM-32 ..... New 1.95
Used .95 (3 for $2.00)

BEAM INDICATORS

I 82—5" ..... New $4.95
Transmitter Selsyn for above 2.45
both for 7.00
I 81—3" ..... New 3.45
Transmitter Selsyn for above 2.45
both for 5.25
I 81 ..... Used 2.45

T-85/APT5 UHF TRANSMITTER

operating over a frequency range of 300 to 1400 MCPC with a nominal output of from 10 to 30 watts. Unit is equipped with 110 V 60 CPS filament transformer, blower, lecher wire test frequency set, and 8 tubes—1-931A; 2-8AC7; 2-6AG7; 1-6L6G; 2-829B; 1-3C22 (GL522) (oscillator).

New in original box with Operating Instruction Manual..... **$69.50**

All shipments FOB Chicago. 20% Deposit required on all orders. Minimum order accepted—$5.00. Illinois residents, please add regular sales tax to your remittance.

Model 15—Ground radar training unit complete. 115 V. 60 C.P.S. operated. Consists of 515 MC transmitter; power supply, and pulse generator. Trains operator to detect land, air or sea targets and can be adapted to various receiver-indicator sets operating at 515 MC. New, with instruction manual. **$225.00**

BC 620

Receiver-Transmitter—2 crystal channels — 20 to 27.8 MC FM—12 tubes. Metered. Plate and Filament ..... New $14.95
Used 9.95

PE 97 Power Supply for above 6-12 volt vibrator type.
Used—complete $6.95
Used less tubes, vib. & cond 2.95
FT 250 Mount for both BC 620 and PE 97 ..... New $1.50

BC 223

Brand new Transmitter with all three tuning units, two tuning unit cases, spare tube carrying case, shock mount and brace, but less tubes at new low price of $19.95
Set of 5 tubes $3.95
Tuning units are available separately as:
Ea. $2.50
Cases at ..... Ea. .95
PE 125—12-volt Vibrator Pack ..... New $12.95
Used 8.95
Spare parts kit for PE 125 containing 2 tubes, 2 vibrators and 12 fuses in metal container with handle and clasp (JAN 41). New $2.95

Send for free 8-page, illustrated BULLETIN #103 listing many exceptional values

ARROW SALES, Inc.
Dept. T5
1712-14 S. Michigan Ave., Chicago 16, Ill.
PHONE: HArrison 7-9374

COMMAND (SCR 274 N) EQUIPMENT

	Used	New
BC-453	$12.95	——
BC-454	4.95	$6.95
BC-455	7.95	——
BC-456	1.95	2.95
BC-457	5.95	——
BC-458	5.95	——
BC-459 (or T22)	9.95	——
BC-696 (or T19)	14.95	24.95
BC-450—2 Receiver Remote Control	.89	1.96
BC-442	1.95	2.95
3 Receiver Rack	1.95	——
2 Transmitter Rack	1.50	——

Complete Command set as removed from aircraft — 2 receivers — 2 transmitters — Relay unit—control boxes—mounting racks—plugs —modulator and dynamotors— crated. Set **$34.50**

HEADSETS—MIKES

HS-23 Hi Imp. Headsets	New	$2.95
HS-33 Lo Imp. Headsets	New	2.95
HS-30 Hi Imp. Headsets	New	1.50
	Used	.79
T-17D Carbon Mike	New	2.75
T-24 Hi Imp. Carbon Mike	New	1.19
T-30 Throat Mike	New	.98
T-45 (or Navy) Lip Mike	New	.98
CD-307 Extension Cord for Headsets	New	.59

CONDENSERS

	Each
2 mfd. 4000 VDC. OIL FILLED	$2.95
	4 for 10.00
1 mfd. 6000 VDC. OIL FILLED	1.98
.25 mfd. 15000 VDC. OIL FILLED	4.95
.00025 mfd. 25000 VDC. OIL FILLED	2.95
4 mfd. 1500 VDC. OIL FILLED	.99
	10 for 2.49
2 mfd. 600 VDC. OIL FILLED	.39
	3 for 1.00
1 mfd. 600 VDC. OIL FILLED	.24
	5 for 1.00
.1x.1x.1—1200 VDC. OIL FILLED	.59
	2 for 1.00
50 mmfd—5KV—6 Amp. Vacuum Cond.	1.19

YOU'RE BEST BET IS LIFE ELECTRONICS

"UHF" COAXIAL CABLE CONNECTORS

No.	AN No.	Description	1-99	100-499	500 or over
83-1SP	PL259	Plug	.35	.28	.24
83-1SS	UG176U	Adapter	.15	.12	.11
83-1SS	UG175U	Adapter	.15	.13	.12
83-1SPN	PL259A	Plug	.35	.28	.24
83-77S	UG201U	Plug	.61	.56	.53
83-1R	SO239	Receptacle	.40	.35	.28
83-1RTY	.....	Receptacle	.50	.45	.40
83-1H	UG106U	Hood	.12	.10	.09
83-1HP	.....	Hood	.27	.24	.21
83-76S	UG177U	Hood	.31	.26	.22
83-1AC	.....	Cap and chain	.61	.50	.48
83-1BC	.....	Cap and chain	.38	.34	.31
83-1T	M358	"T" connector	1.12	.90	.90
83-1AP	M359A	Angle adapter	.35	.28	.24
83-1J	PL258	Junction	.85	.70	.65
83-1F	PL274	Feed thru	1.12	.98	.90
83-22SP	UG102U	Twin plug	.75	.68	.62
83-22R	UG103U	Twin recept	.50	.40	.36
83-22AP	UG104U	Twin ang. adapt.	.98	.80	.72
83-22J	UG105U	Twin junction	1.25	1.12	1.05
83-22T	UG106U	Twin "T"	1.65	1.50	1.35
83-22F	PL275	Twin feed thru	1.50	1.35	1.25
83-2SP	PL295	Lge twin plug	1.94	1.75	1.55
83-2R	SO265	Lge twin recept.	1.44	1.30	1.18
83-2H	M365	Lge Hood	.24	.22	.20
83-2AC	.....	Lge CAP and chain	.61	.55	.50
83-2AP	PL325	Lge Twin angle adpt.	2.08	1.88	1.66
83-2J	PL365	Lge twin junction	1.45	1.30	1.18

POTENTIOMETERS

TYPE "J" AND "JL"

Available in screw driver and regular shafts locking and non-locking type bushings.
When ordering locking type bushing potentiometers, locking nuts are available at $.05 each.
Specify whether regular or screwdriver shaft is required.

PRICE SCHEDULE

Single Pots	$.50
Dual Pots	1.50
Triple Pots	2.50

SINGLE POTENTIOMETERS TYPE "J" AND "JL"

Ohms	Ohms	Ohms	Ohms
50	1200	20,000	200,000
60	1500	25,000	250,000
100	2000	30,000	500,000
200	2500	35,000	600,000
250	3000	50,000	750,000
400	5000	60,000	1 MEG
500	6500	75,000	2 MEG
			2 5MEG
600	10,000	100,000	3 OMEG
1,000	15,000	150,000	4 OMEG

DUAL POTENTIOMETERS TYPE "JJ"

Ohms	Ohms
60/60	10,000/25,000
100/100	20,000/35,000
500/500	20,000/700,000
600/600	25,000/25,000
1800/1800	50,000/50,000
2500/2500	75,000/75,000
3000/3000	100,000/100,000
5000/5000	200,000/200,000
7500/7500	500,000/500,000
10,000	1 Meg/1 Meg
10,000	5 Meg/5 Meg

TRIPLE POTENTIOMETERS TYPE "JJJ"

Ohms	Ohms
160,000	150,000/150,000
500,000	500,000/500,000

COAXIAL CABLES

BRAND NEW!!

JAN APPROVED !!

RG No.	Impedance	Price per Thousand Ft.
RG5U	52.5 ohms	$70.00
RG6U	76.0 ohms	150.00
RG7U	97.5 ohms	70.00
RG8U	52.0 ohms	60.00
RG9U	51.0 ohms	135.00
RG9AU	51.0 ohms	125.00
RG10U	52.0 ohms	125.00
RG11U	75.0 ohms	100.00
RG12U	75.0 ohms	190.00
RG13U	75.0 ohms	125.00
RG18U	52.0 ohms	450.00
RG19U	52.0 ohms	350.00
RG20U	52.0 ohms	450.00
RG22U	95.0 ohms	120.00
RG24U	125.0 ohms	240.00
RG25U	48.0 ohms	575.00
RG27U	48.0 ohms	290.00
RG29U	53.5 ohms	50.00
RG34U	71.0 ohms	175.00
RG38U	52.5 ohms	400.00
RG39U	72.5 ohms	180.00
RG41U	67.5 ohms	575.00
RG54U	58.0 ohms	65.00
RG54AU	58.0 ohms	75.00
RG57U	93.0 ohms	100.00
RG58U	53.5 ohms	50.00
RG59U	73.0 ohms	40.00
RG62U	93.0 ohms	50.00
RG65U	950.0 ohms	450.00
RG71U	93.0 ohms	175.00
RG74U	52.0 ohms	250.00
RG75U	48.0 ohms	50.00

Prices based on a minimum quantity of 500 ft. For cut lengths add 50% to prices shown.

SILICON DIODES

Type	Design Freq. (mc)	Price each
1N21	3,000	$.50
1N21B	3,000	1.00
1N23	10,000	1.25
1N23A	10,000	1.50
1N23B	10,000	2.00

GERMANIUM DIODES

Type	Price each
1N34	$.85
1N35	2.00

SEND FOR OUR FREE A.B. BULLETIN

COMING !!

OUR NEW COMPREHENSIVE FLYER # J666. GET ON OUR MAILING LIST NOW.

RESISTORS

EB½, GB1 and HB2

LIFE OFFERS THE MOST COMPLETE INVENTORY OF ½, 1 and 2 WATT RESISTORS IN 5% and 10% TOLERANCES IN THE COUNTRY

PRICE SCHEDULE

	Wattage	Tol.	Quantity per Type 500 or over 1-49	50-499	
EB½	½ Watt	10%	.06	.04	.025
EB½	½ Watt	5%	.12	.08	.05
GB1	1 Watt	10%	.09	.06	.045
GB1	1 Watt	5%	.18	.12	.09
HB2	2 Watt	10%	.15	.10	.075
HB2	2 Watt	5%	.30	.20	.15

Prices shown are per stac. Resistors may not be assorted for quantity price.

THE FOLLOWING VALUES ARE AVAILABLE IN 10% TOLERANCE:

Ohms	Ohms	Ohms	Ohms	Megs	Megs	Megs
10	100	1000	10000	1	10	100
12	120	1200	12000	1.2	12	120
15	150	1500	15000	1.5	15	150
18	180	1800	18000	1.8	18	180
22	220	2200	22000	2.2	22	220
27	270	2700	27000	2.7	27	
33	330	3300	33000	3.3	33	
39	390	3900	39000	3.9	39	
47	470	4700	47000	4.7	47	
56	560	5600	56000	5.6	56	
68	680	6800	68000	6.8	68	
82	820	8200	82000	8.2	82	

THE FOLLOWING VALUES ARE AVAILABLE IN 5% TOLERANCES:

Ohms	Ohms	Ohms	Ohms	Ohms	Megs	Megs	Megs
10	68	470	3300	22000	0.15	1.0	6.8
11	75	510	3600	24000	0.16	1.1	7.5
12	82	560	3900	27000	0.18	1.2	8.2
13	91	620	4300	30000	0.20	1.3	9.1
15	100	680	4700	33000	0.22	1.5	10.0
16	110	750	5100	36000	0.24	1.6	11.0
18	120	820	5600	39000	0.27	2.0	12.0
20	130	910	6200	43000	0.30	2.2	13.0
22	150	1000	6800	47000	0.33	2.2	15.0
24	160	1100	7500	51000	0.36	2.4	16.0
27	180	1200	8200	56000	0.39	2.7	18.0
30	200	1300	9100	62000	0.43	3.0	20.0
33	220	1500	10000	68000	0.47	3.3	22.0
36	240	1600	11000	75000	0.51	3.6	
39	270	1800	12000	82000	0.56	3.9	
43	300	2000	13000	91000	0.62	4.3	
47	330	2200	15000	1	0.68	4.7	
51	360	2400	16000	0.11	0.75	5.1	
56	390	2700	18000	0.12	0.82	5.6	
62	430	3000	20000	0.13	0.91	6.2	

KINGS — UG CONNECTORS — IPC

UG 88/U

UG 290/U

Deduct 10% from prices shown on quantities of 100 or more of a type

AN No.	Price ea.	AN No.	Price ea.	AN No.	Price ea.	AN No.	Price ea.	AN No.	Price ea.
UG-9 U	.95	UG37 U	16.00	UG98A U	1.75	UG203 U	.61	UG260 U	.90
UG10 U	1.56	UG37A U	16.00	UG100 U	2.34	UG204 U	2.55	UG261	.95
UG11 U	1.45	UG38A U	20.00	UG100A U	2.65	UG204A U	2.25	UG262 U	1.05
UG12 U	.95	UG39 U	1.25	UG101 U	2.95	UG206 U	2.82	UG269 U	1.60
UG13 U	1.56	UG40 U	1.34	UG101A U	3.20	UG207 U	18.00	UG270 U	6.50
UG14 U	1.45	UG43 U	2.00	UG107 U	2.25	UG208 U	18.00	UG271 U	6.50
UG15 U	.95	UG46 U	2.00	UG107A U	2.30	UG209 U	4.50	UG272 U	16.00
UG16 U	1.56	UG57 U	1.75	UG107B U	2.55	UG212A U	4.00	UG273 U	1.22
UG17 U	1.45	UG57B U	1.40	UG108 U	1.75	UG213 U	3.35	UG274 U	1.98
UG18 U	.99	UG58 U	6.5	UG108A U	2.25	UG213A U	3.00	UG275 U	4.50
UG18A U	1.65	UG58A U	.73	UG109 U	1.85	UG215 U	3.35	UG276 U	4.50
UG18B U	1.56	UG59 U	2.25	UG109A U	1.75	UG216 U	8.70	UG279 U	2.40
UG19 U	1.26	UG59A U	1.70	UG110 U	10.20	UG217 U	4.35	UG287 U	5.25
UG19A U	1.56	UG60 U	1.90	UG114 U	1.50	UG218 U	6.50	UG290 U	.85
UG19B U	1.45	UG60A U	1.30	UG115 U	1.35	UG219 U	4.50	UG291 U	1.05
UG20 U	1.17	UG61 U	2.05	UG119P U	6.50	UG220 U	6.50	UG306 U	2.03
UG20A U	1.26	UG61A U	1.80	CW123 U	.41	UG222 U	35.00	UG333 U	4.70
UG20B U	1.41	UG62 U	25.00	UG131 U	1.75	UG224 U	1.14	UG334 U	5.75
UG21 U	.99	UG63 U	1.50	UG146 U	2.05	UG231 U	2.00	UG348 U	2.75
UG21A U	1.05	UG65 U	1.65	UG154 U	8.35	UG233 U	13.00	UG349 U	2.34
UG21B U	.99	UG66 U	1.69	CW155 U	.41	UG234 U	13.00	UG352 U	6.00
UG22 U	1.05	UG67 U	1.40	UG155 U	8.35	UG235 U	28.50	UG353 U	6.50
UG22A U	1.35	UG68 U	1.00	UG156 U	4.25	UG236 U	7.50	MT412 U	.75
UG22B U	1.14	UG69 U	.95	UG157 U	4.25	UG237 U	13.00	UG414 U	2.34
UG23 U	.99	UG80 U	1.02	UG158 U	38.10	UG241 U	2.70	UG421 U	2.50
UG27 U	1.25	UG91 U	1.25	UG159A U	1.55	UG242 U	3.25	UG422 U	2.50
UG27A U	2.52	UG91A U	1.05	UG160A U	1.90	UG243 U	3.75	UG423 U	4.65
UG27B U	1.25	UG92 U	1.10	UG160A U	1.55	UG244 U	3.50	UG475 U	20.00
UG27C U	2.52	UG93 U	1.30	UG166 U	38.10	UG245 U	2.25	UG479 U	20.00
UG28 U	2.34	UG93A U	1.25	UG167 U	3.00	UG246 U	2.45	UG480 U	20.00
UG28A U	2.54	UG93A U	1.37	UG167A U	4.25	UG249 U	13.00	UG483 U	3.45
UG29 U	1.22	UG94 U	1.25	UG173 U	.30	UG250 U	13.00	UG484 U	4.30
UG29A U	1.56	UG94A U	1.85	UG174 U	16.00	UG251 U	13.00	UG486 U	1.65
UG29B U	1.56	UG95 U	1.10	UG175 U	.15	UG252 U	4.50	UG487 U	4.90
UG30 U	1.75	UG95A U	1.14	UG176 U	.15	UG253 U	4.25	UG491 U	1.60
UG32 U	16.00	UG96 U	1.25	UG188 U	.95	UG254 U	2.85	UG493 U	13.00
UG33 U	16.00	UG97A U	1.25	UG188A U	1.25	UG254A U	2.25	UG494 U	3.65
UG34 U	17.50	UG97 U	3.20	UG197 U	5.00	UG255 U	1.40	UG495 U	6.00
UG35A U	16.00	UG97A U	3.40	UG201 U	1.65	UG256 U	11.00	UG496 U	2.34
UG36 U	16.00	UG98 U	1.88	UG202 U	3.75	UG257 U	11.00	MS3504 U	.36

LIFE ELECTRONIC SALES • 91 GOLD STREET • NEW YORK 7, N. Y. • DIGBY 9-4154

Reliance Specials

HAYDON TIMING MOTORS

4 R.P.M., 115V., 60 Cycle $1.79
2/3 R.P.M., 115 V., 60 Cycle. 2 motors connected on one shaft to make unit reversible. ONLY $1.95

POWER RHEOSTATS

STANDARD BRANDS

25 WATT			25 WATT			150 WATT		
Resist.	Shaft		3,000Ω	¼"	69¢	123Ω	½"	79
10Ω	¼"	49¢	5,000	S.D.*	69	1,250	½"	89
15	¼"	59				2,000	½"	89
25	¼"	59	50 WATT			3,500	½"	89
145	½"	49						
	with switch		8Ω	S.D.*	79¢	8Ω	½"	$1.99
250	¼"	59	20	¼"	79	*S.D. Screw Driver Slot.		
370	½"	59	80	½"	79¢			

UNIVERSAL JOINT

3/16" hole x 3/8" O.D.
1 1/8" long
Steel or Aluminum
50¢

TIME DELAY RELAY

Raytheon CPX 24106 KS 16195, 60 Sec.
• 115 V., 60 Cycle • Adj. 50-70 Seconds • 2½ second recycling time—spring return • Micro-switch contact, 10A. • Holds ON as long as power is applied • Fully cased
ONLY $6.50

CARBON RESISTOR ASSORTMENT

Color coded, insulated ..... 100 only $1.29

PULSE TRANSFORMERS

X 124 T2, UTAH, marked 9262, small gray case. Ratio 1:1:1, hypersil core $1.50
D161310, 50 Ko to 4 Mc. 1⅝" dia. x 1⅞" high. 120 to 2550 ohms $1.50
157-7178—Spec. 10, 111 Chicago Trans. equivalent to 9262 (above) $1.00
D196638 W.E. Permalloy core. Semi toroidal windings $1.25
KS8800, Ratio, 1:1:1, 2:1, Freq. range 380 to 520 C.P.S. $3.50
D196173, W.E. Freq. resp. 10KC to 2 MC $9.80
300 KVA GE K 2488B, 50 ohm pulse cable connection, 0.850 V. in., 17,500 V. out (250 KVA @ ⅛ microsecond) $13.75
600 KVA G.E. K2731, 28000 Volt pk. output. Rittay rate microsecond pulse width $14.50

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2-140Y	$.05	4-141W	.22	9-141½W	$.42
2-140½W	.10	4-141½W	$.22	9-141Y	.47
2-140¾W	.13	4-141¾W	.22	10-141¼W	.52
4-140	.15	5-141	.20	12-141	.44
8-140	.25	5-141Y	.27	14-140Y	.56
8-140W	.33	5-141¼W	.27	17-141Y	.87
10-140¼W	.40	7-141	.27	3-142	.15
13-140	.37	7-141½W	.37	5-142	.24
2-141	.60	7-141Y	.37	6-142	.28
4-141½W	.12	8-141	.37	10-142¼W	.64
4-141W	.17	8-141½W	.42	2-150	.28
4-141Y	.17	8-141¾W	.42	4-150	.52

0-15A BASIC MOVE 12 Mo. 5" x 4" METAL CASE MIRROR SCALE

Lots of 10—$3.85 ea.

DC AMMETER

CHOKE

400 MA
12 Hy.
90 OHM
6,000
V. D. C.
TEST
$3.85
10 for $34.00

PRECISION CONTROLS

6 WATT

20,000	Muter	314A	*1.70
20,000Ω	GR	314A	2.50
6,000	De jur	290	1.70
6,000	Muter	314A	1.70
5,000	Muter	314A	2.50
5,000	GR	214A	1.40
2,000	De jur	290	1.70

25 WATT

100K	GR	433A	$4.95

4 WATT

500Ω	Centralab	48-501	$.90
50	De jur	292	.75
50	GR	301	1.10
25	GR	301	1.10
20	De jur	292	.75
12	GR	301	1.10

12 WATT

10,000	Muter	471A	$2.00
10,000Ω	De jur	271T	2.00
5,000	De jur	271T	2.00

7 Terminal Bakelite tie point ..... 35 for $1.00

VERNIER DIAL (From BC-221)

2 ⅝" Dia. 0-100 in 360°. Black with silver marks. Has thumblock ..... 85¢

CARBON MIKE

T-17—Slightly used, guaranteed, 3 ft. cord & PL 68 ..... 69¢

FILAMENT TRANSFORMER

Amertran Type WS

For High Voltage Rectifiers. PRI. 115V., 50/60 Cycle.

SEC. 5V., C/T @ 10 Amp.

35 KV R.M.S. Test 12 KV D.C. Operating. Uses 872A Tube or other tubes.

NEW OVERSEAS PACKED $10.95

872-A Tube... $1.98

ALLEN SET SCREWS

4-40 x 1/4	8-32 x 1/4	8-32 x 5/16
4-40 x 5/16	8-32 x 3/16	8-32 x 3/8
ALL SIZES (Cup Point)		$1.50 per 100
GLYPTOL CEMENT 1 oz.		75¢

Wrapped—BALL BEARINGS—New

Mfg	ID	OD	Width	Price
Fafnir 33KS	3/16"	1/2"	5/32"	.25
N.D. 30	3/16"	1/2"	9/32"	.45
Fafnir K8A	1/2"	1 1/16"	5/16"	.60
N.D. 5202C13M	1/2"	1 3/8"	1.8"	1.00
Fafnir 7508W	1 37/64"	3 9/16"	5/16"	2.00
SKF 466430	6"	8"	1"	5.00
SKF170645	3 11/32"	4 1/8"	7/16"	1.50
Fafnir 545	2 1/16"	2 5/8"	15/32"	1.00

NEEDLE BEARINGS

B108 1/2" wide	5/8"	13/16"	30¢
GB34X 1/4" wide	3/16"	11/32"	25¢

SOUND POWERED HANDSET

Brand New! TS-10

Includes 6 ft. cord & spring clips
$8.92 ea. — $17.50 pr.

WALL HANGER — Navy type, for Sound Powered Phones (Shown above) ..... $1.00 each

FUSES

3AG		3AG	
⅛ Amp	$4.00 per 100	3 Amp	$2.50 per 100
¼	4.00	4	2.75
⅝	4.00	5	2.50
1	2.50	10	3.00
1½	2.50	15	3.00

Fuse Holder—Littlefuse for 4AG fuse ..... 18¢

COAXIAL CABLE

RG 8/U 52 OHM

$55.00 per 1,000 feet

	Ohm	Price per 1,000 ft.		Ohm	Price per 1,000 ft.
RG 5/U	53.5	$70.00	RG 27/U	48	$290.00
RG 7/U	97.5	60.00	RG 29/U	53.5	50.00
RG 8/U	52	50.00	RG 34/U	71	175.00
RG 9/U	51	135.00	RG 39/U	72.5	180.00
RG 10/U	52	125.00	RG 41/U	67.5	575.00
RG 11/U	75	100.00	RG 54/U	58	65.00
RG12/U	75	190.00	RG 54/AU	58	75.00
RG 13/U	74	125.00	RG 55/AU	53.5	60.00
RG 18/U	52	450.00	RG 57/U	95	100.00
RG 19/U	52	350.00	RG 58/U	53.5	50.00
RG 20/U	52	450.00	RG 59/U	73	50.00
RG 22/U	95	110.00	RG 62/U	93	50.00
RG 24/U	125	240.00	RG 74/U	52	250.00
RG 25/U	48	575.00	RG 77/U	48	100.00

COAXIAL CABLE CONNECTORS

Angle-Adapter 15¢	Plug 25¢	Socket 25¢	Hood 9¢
M-359	PL-259A	SO-239	83-1H
83-1AP	83-1SPN	83-1R	

Adapter for PL-259 A for use on small coax cable ..... $10.00 per 100

83-1SP	$.28	83-22SP	.48	UG 27/U	.60
83-1J	.80	83-2J	1.50	UG 59/U	.60
83-1T	1.12	UG 13/U	.60	UG 61/U	.60
83-1F	1.12	UG 21/U	.60	UG 85/U	.60
83-22AP	.85	UG 22/U	.60	UG 87/U	.50
83-22R	.48	UG 24/U	.60	UG 167/U	2.00
		UG 25/U	.60	UG 281/U	.60

CAPACITORS

POSTAGE STAMP MICAS

MMF	MMF	MMF	MMF	MFD
8.2	60	250	620	.00136
10	62	300	650	.0015
15	68	350	680	.002
20	75	370	700	.0026
22	82	390	750	.0027
24	90	400	800	.003
25	100	430	820	.0033
30	110	470	900	.004
39	150	500	910	.005
40	160	510	MFD	.0068
47	200	560	.001	.0075
51	220	580	.0012	.0082
56	240	600	.0013	.01

Price Schedule

8.2	MMF to .001	MFD...	5¢
.0012	MFD to .002	MFD...	7¢
.0026	MFD to .0082	MFD...	12¢
.01	MFD...		18¢

SILVER MICA

MMF	MMF	MMF	MMF	MFD
10	120	360	600	.0027
24	125	370	680	.003
30	150	390	700	.0033
40	180	400	820	.0039
50	200	430		.004
60	208	466	MFD	.0047
62	225	470	.001	.005
66	240	488	.0013	.0051
68	250	500	.0018	.006
75	300	510	.002	.0082
100	325	525	.0022	.01
110		560	.0024	

10	MMF to .001	MFD...	10¢
.0012	MFD to .0027	MFD...	25¢
.003	MFD to .0082	MFD...	50¢
.01	MFD...		65¢

OIL FILLED

MFD	V.D.C.	Price
.375@	16,000 and	
7@8	8,000 (dual)	$6.95
4	10,000	8.95
5	7,500	23.95
1	7,500	1.50
1-1	7,000	1.50
.02-.02	7,000	1.50
1	6,000	1.50
2	4,000	4.50
.25	3,000	1.95
2 x 1	2,000	.95
1	2,000	.95
4	1,000	.95
1	1,000	.95
2	1,000	.95
10	600	1.00
2	600	.95
4	600	.95

SELSYNS

115 V., 60 Cyc.
=C78248
3⅛" dia. x 5⅛" long
$7.95 pair

Mounting Brackets — Bakelite for selsyns and differentials shown above ..... 25¢ pair

DIFFERENTIAL

115 V., 60 Cyc.
=C78249
3⅛" dia. x 5⅛" long
$2.25 ea.

Used between two =C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted ..... $3.00)

WW PRECISION RESISTORS, 1% OR BETTER

¼ WATT—25c

6.68Ω	12.32Ω	16.37Ω	123.8Ω	414.3Ω
10.48	13.02	20	147.5	705
10.84	13.32	62.54	220.4	2193
11.25	13.89	79.51	301.8	10,000
11.74	14.98	105.8	366.6	59,145

½ WATT—25c

250Ω	11.10	210Ω	3,447Ω	8,560Ω
334	13.15	235	4,000	14,525
502	46	260	4,451	15,000
557	52	270	5,000	15,750
627	55.1	298.3	5,000	17,000
76	75	400	6,500	30,000
1.01	97.8	723.1	7,000	100,000
1.53	125	2,500	7,560	
2.04	180	2,850	8,000	

1 WATT—30c

1.01Ω	5.21Ω	270Ω	7,000Ω	65,000Ω
2.8	10.1	1,250	9,000	65,000
3.39	10.9	3,360	18,000	70,000

1 WATT—40c

100,000Ω	128,000Ω	180,000Ω	522,000Ω
120,000	130,000	320,000	600,000
125,000	160,000	470,000	700,000

1 Megohm—1 Watt 1%—65c; 5%—40c

100 pieces—10% off; 1,000 pieces—20% off.

DELAY NETWORK—ALL 1400Ω

T 113—Approx. 1.2 micro sec. delay	85¢
T 114—Approx. 2.2 micro sec. delay	85¢
T 115 Similar to T 114 with tap brought out	85¢

MICRO AMMETER 0-500

2" round. Basic movement 500 micro amps. Used. Guaranteed ..... $3.21 ea.

POSTAGE STAMP MICA ASSORTMENT

100 asst. regular and silver micas $3.29
10 Conductor shielded cable, 5 ft. long & complete 400 series Jones plug ..... 98¢

#18 SHIELDED WIRE—STRANDED

Single Conductor	—100 ft.	$1.95	1,000 ft. $12.50
Two Conductor	—100 ft.	$2.95	1,000 ft. $19.50

Write for Monthly Bulletin

Gear Assortment $6.50

Experimenters dream, 100 pieces, many stainless steel.

TRANSMITTING MICAS
UPRIGHT BAKELITE CASE

MFD	V. D. C.	Amps	KC	Price
.00032	5,000	2.5	1,000	$.89
.0003	5,000	4	1,000	.95
.0011	5,000	6	1,000	.99
.002	5,000	4	300	.99
.015	2,000	12	300	1.09
.024	1,500	15	1,000	.99
.033	1,500	15	1,000	.99
.05	1,500	13	300	.99
.062	1,000	18	1,000	.99
.075	1,000	18	1,000	.99

CHROMALOX STRIP HEATER—115 V.A.C.

60 Cycle, 750 Watt, curved ..... 95¢

Minimum Orders $3 ..... All orders f.o.b. PHILA, PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. *Telephone RIttenhouse 6-4927*

BLOCKING OSC. TRANSFORMERS

C-124. 3 windings. 7, 14 and 2 Ohms D.C. respectively. Completely shielded, with mounting ears on base. Standoff terminals on side. Diagram on adjacent side ..... 85¢ ea.

SCANNING TRANSFORMER

#66021. 9 V. RMS @ 10 Cps. .12 Ohms D.C. Res. Pri. 650 Ma. Sec.: 680 Ohms, 375 V. Open Frame. New ..... 89¢

TRANSFORMER ASSORTMENT

Ten Special Selected units, ideal for the Lab, experimenter, etc. A Value you can't afford to miss! The Ones are Worth More! All Good! Approx. 60 Lbs. $4.95. (Shipped Railway Express Only).

COAX CONNECTORS

101U/52B—British Chassis Male 39¢ ea., 3 for $1.00
101U/52G—British Elbow—Male to Male ..... 59¢ ea., 3 for $1.00
QA 49047—British to Standard Male Adaptor ..... 75¢ each, 3 for $2.00
UG-21/U—Utilitate Pin Connector ..... 39¢ ea., 3 for $1.00
UG-27/U—90° Pin Elbow Male to Female ..... 75¢ ea., 3 for $2.00
M 359 A—90° Std. Elbow Male to Female ..... 75¢ ea., 3 for $2.00

TELEPHONE REPEATER COIL

C-161. 1:1 Ratio. One side center tapped for Feeding Keying Lines into telephone circuits. Completely shielded with terminals mounted on heavy insulated base. Diagram etched in metal cover plate. Like New ..... $1.49 each

PIONEER TORQUE UNITS

Type 12003-1 A400 Cyc. 26 Volts, Brand New. Sealed in carton ..... $7.95 ea.

MAGNIFIER REFLECTOR

8" Dia. Parabolic (Lancaster Lens) Metallic coated silver surface. Useful in photographic work. (Glass) Ships. Wt. Approx. 1½ Lbs. New $1.95

V.H.F. ANTENNA

AT-50/TRC. Telescopic. Adjustable from 15¾" to 27⅞". Mounts with standard coaxial male connector. Two sections. Locks at any setting. Light weight and low wind resistance. New. Ideal for cabs, police cars, etc. $1.39

SELENIUM RECTIFIERS

Half wave (Ratings with 500 Mfd. Cap. on output): #1A3 ..... A.C. Input: 18V., D.C. Output: 14V. @100 Ma. New ..... 34¢
#1H4 ..... A.C. Input: 28V., D.C. Output: 24V. @750 Ma. New ..... 75¢

MICROMETER

1" Brownie. Hardened Steel with polished Barrel and calibrations. Adjusting screw at end of barrel. Without Ratchet. New $2.25

FILTER CHOKES

C-2308. 8 Hy. 300 Ma. 80 Ohms D.C. 2000 V. Ins. Completely shielded in upright case with leads coming from bottom. New $3.95
LC-0101. .072 Hy. 450 Ma. 2.5 Ohms D.C. Shielded. Upright can. New ..... 59¢ each

TELETYPE FILTER

W.E. 189A. Has 15 lugs topside, string capacities .0015, .002, .006, .012, .027, .05, and 1 Mfd. Size: 1⅝" X 1¾" X 2¼" H. Metal can with mounting lugs. New ..... 65¢ each
(15% discount in lots of 25 or more)

COMPASS INDICATOR

1 #2 A 3" Dia. Face. Manually variable scale. Uses a PL-118 Plug. New, overseas packed $4.95

REEL CONTROL BOX

BC-461 A. Mounted in moulded bakelite case. Size: 1⅝" L X 2¼" W X 2⅝" H. Overall. Contains 3 Pos. Switch marked "in", "off", "out". Indicator Jewel Lite and 3 digit counter with manual reset wheel. MS-92 Connector and Spline cable fitting on end apron. Panel removable from base by removing 2 cutter screws. New ..... 95¢

LINEN PHENOLIC TUBING

O.D. 1⅝" x .032" wall. Over 2 Ft. long. Unvarnished orange linen finish ..... 45¢ per length

HAND COUNTER

3 digit with manual reset. Finger button lever in front. 1⅜" H. X 2" D. X 1 3/16" W. Finished in brown wrinkle. Stands on flat surface. New. $1.29

TORROIDAL POTENTIOMETER

No. KS-15138—Two rotating brushes take off Linear Sawtooth voltage from continuous resistance winding which is fed 24 V.D.C. to two taps 180° apart. Die cast aluminum case. Type AN Connector. Brand New $2.75

SHIELDED RHEOSTATS

Type "J" 90 ohms at 1.35 Amps. Max. Enclosed in ventilated metal housing with insulated terminals at the back. Shaft: ¼" X ½" L. ⅜" single hole mtg. New ..... 98¢

FILTER CRYSTALS

400 5 K.C. Mounted, with Terminal lugs on either end. Size: ½" X ½" X 1". New. 89¢ ea., 3 for $2.00

ANTENNA ROTATOR—RL-42

A natural for Lightweight FM or TV Antenna. Approx. 12 R.P.M. Reversible. Magnetic Clutch. Motor operates on 24 V.D.C. @ 5.5 Amps. Operates on A.C. New, with bobbin on shaft $3.95

VIBRATORS

Type VB-11-A 24 V. Non Sync. 9 pin offset base. New ..... 59¢
Type WE-KS-5506 12 V. 60 Cyc. Non-Sync. 4 pin Std. base. New ..... 69¢

COAX LEAD

19" length RG 8U with Silver plated PL-259 Male Conn. on one end and Heavy Copper Lugs spaced 1¾" apart at other end. Lugs have 3/16" hole. New ..... 79¢ each

RELAY SELECTOR UNIT

BC 685 A. Consists of two individual band-pass filters, 450 cycles and 700 cycles, each uses 3 25L6GT and 1-12H6 tubes. Components include 14 telephone type relays, 200 and 500 ohm coils, one 25 position 4 circuit rotary relay with 12 ohm coil, band-pass transformers, networks, resistors, condensers, etc., etc. Panel controls are missing. Heavy gauge chassis and panel. Size: 8⅝" x 11⅝" x 19". Metal hood encloses entire unit. Ships. Wt. Approx. 55 Lbs. Express only. Like new, less tubes $14.95

H.V. RECTIFIER SOCKETS

Ceramic 4 Pr. large. Fits 705-A and similar tubes. New ..... 45¢ each

MARKER OSC. COIL

Type CAY. 92 K.C. Hermetically sealed in round drawn Aluminum can/chassis, 2" D. X 3" L. Slug tuned. Ceramic terminal board on bottom. New ..... 95¢ each

20-28 MC. OSC. COIL

For BC-603 Receiver. Silver wire wound on Ceramic or Mycalex form. Fungus treated. Temp. Compensated and tested. New overseas packing. 69¢ each

JUNCTION BOX

J-66-A. For PL-215 Inserts. 1/16" Welded Aluminum Housing, 7½" L. X 6¼" W. X 2½" H. Has 3 AN Connectors in end aprons and two 6 terminal barrier strips inside. New ..... 79¢ each

SPECIAL CONDENSERS

500 MFD. 200 V.D.C. Round Drawn Aluminum can, 2" D. X 4½" L. with mounting base. Hermetically sealed. Terminals on top. May be inverted as terminals are on the bottom. Can not grounded. New ..... 95¢ each
(Discount 10% for lots of 25 or more)
40 + 40 MFD. 250 V.D.C.—Round drawn Aluminum can 1⅝" D. X 3⅝" L.—Neg. not grounded in can. Hermetically sealed. New ..... 65¢ each
(Discount 15% for lots of 25 or more)

BC-423 RADAR MODULATOR

A sturdy and beautifully built RF Oscillator 125 to 250 Mc. (Approx.) pulse is diluted at 800 C.P.S. Uses 1-955, 2-837, 4-6SL7 and 1-6V6 all in series at 115 V. 60 Cyc. May be modified for T.V. General, etc. New with tubes. Ships. Wt. Approx. 45 Lbs ..... $ 2.50

ARR-1 RECEIVER

Attractively built T.R.F. using 1-954 Acorn tube. Originally operated on 234-258 Mc. Can be modified for converter on 6, 2 or 1 meters. Q permeability tuning. Ships Wt. Approx. 7 Lbs. Complete with tubes. New 12.75

HOOKUP WIRE

Cut lengths from 2" to 14" long in various colors and types of insulation. All cuts are stripped and tinned. A superb value! 3 Lbs. for $1.00
Quantity Prices on Request. Write for Free Flyer!!! Quantities Limited!!! 50¢ packing charge on orders below $2.00. Minimum Depot $2.00. No C.O.D. orders. Prices F.O.B. Chicago. $10.00 Minimum. Foreign Order Acceptable.

• TUBES •

1B3/8016	$1	49	6SH7	$0	45	2J21A	$10	95
5R4GY	1	10	6SJ7		52	2J56	9	50
5T4		75	6SK7GT		49	2K25	23	50
5U4G		59	6SL7GT		64	2K45	9	50
5V4G		88	6SN7GT		59	2S3A	10	95
5W4		72	6SQ7		55	303A	3	95
5X4G		62	6SS7		55	307A	3	75
5Y3GT		42	6V6		94	316A		49
5Z3		69	6V6GT		65	4-65A	14	10
6A7		74	6W4		69	4-125A	25	95
6AC7		79	6Y6G		69	GL302	1	98
6AG5		74	7C5		53	703A	1	95
6AG7	1	03	7F7		64	707B	10	95
6AK5		85	7N7		73	715B	9	95
6AK6		82	7Y4		52	715C	24	50
6AL5		62	7Z4		62	723AB	11	95
6AQ5		54	12A6		21	725A	8	95
6AT6		48	12AT6		49	803	4	50
6AU6		62	12AT7		62	804	12	95
6B4G		94	12AU6		68	805	5	95
6B6G		84	12AU7		70	809	2	25
6BA6		59	12BA6		59	810	8	95
6BE6		57	12BE6		53	811	2	49
6BG6G	1	49	12SA7		60	813	9	95
6BH6		62	12SK7		60	814	3	95
6C4		25	12SQ7		55	815	1	57
6C5		49	25L6GT		69	816	1	05
6C6		52	25Y5		49	826		49
6C8G		59	35W4		45	829B	7	95
6D6		49	35Z5GT		47	830B	4	95
6F5		52	50B5		58	832A	4	95
6F6		62	50L6GT		58	836	1	75
6F8G		79	80		49	837	2	45
6H6		42	83		79	845W	4	85
6J5		49	117L7	1	29	866A	1	15
6J6		89	0A2	1	55	872A	1	49
6J7		72	0B2	1	76	892R	250	00
6K6GT		49	VR75		89	1625		18
6K7		53	VR90		95	2050	1	20
6K8		85	VR105		89	2051		85
6L6	1	19	VR150		69	8025	3	75
6N7		79	1N21		85	9001		39
6SA7		58	1N23		85	9002		30
6SC7		64	1N34		80	9003		40
6SF5		53	1N35	2	05	9004		29
6SG7		64	2D21		95	9005	1	60

3" METERS

0-20 ua DC WH	$18	50	0-30 AMP AC TRIP	$5	95
0-50 ua DC WH	17	50	0-50 AMP AC WH	5	95
0-200 ua DC WH	10	25	0-75 AMP AC TRIP	5	95
0-1 MA DC WH	7	50	JBT 31-FFR MTR	7	95
0-1 MA DC S meter	3	95	**2" METERS**		
0-2 MA DC WH	4	95	0-200 ua DC	4	50
0-2 MA DC SIMP	3	95	0-500uaDCSPScale	4	25
0-5MA DC SP SCALE	2	95	0-1 MA DC 500	3	95
0-15 MA DC GE SQ	3	95	0-1 MA DC SUN	3	85
0-20 MA DC WH	3	95	0-5 MA SPScale SQ	2	49
0-30 MA DC GE	4	50	0-5MAGEAMPScle	2	49
0-50 MA DC WH	4	50	0-10 MA WH	2	49
0-80 MA DC WE	2	95	0-20 MA SP Scale	2	49
0-100 MA DC DEJ	4	50	0-25 MA SP Scale	2	49
0-150 MA DC WH	4	50	0-50 MA GE	2	49
0-200 MA DC GE	4	50	0-100 MA	2	49
0-750 MA DC GE	4	75	0-20 VDC WEST	2	75
0-1 AMP DC WH	4	95	0-30 VDC GE	3	25
0-2 AMP DC SIMP	3	95	0-10 AMP DC GE	3	50
0-300 VDC SUN	7	95	0-300 VAC TRIP	4	95
0-8 VAC WES 476	4	50	0-250 MA AC GE	3	95
0-15 VAC GE	4	50	0-1 AMP RF GE	3	50
0-10 + 50 DB Wes 301	8	95	0-1 AMP RF SQ	3	50
0-150 VAC WH	5	95	0-4 AMP RF GE	3	50
0-25 AMP AC WH	5	95	0-9 AMP RF WH	3	50
0-200 ua 4" SQ.			Volt. 300 Ohm scale	$7	95

CHOKES

200 HY 6 MA 620 OHM	$ .99
8 HY 50 MA 80 OHM	.39
10 HY 80 MA 240 OHM	.89
20 HY 110 MA SUP SIG HERM SEAL	3.45
10 HY 150 MA 160 OHM	1.39
5 HY 200 MA65 OHM SUP SIG	3.95
7 HY 200 MA 100 OHM HERM SEAL	2.49
4-16 HY 200 MA 140 OHM SW CH	3.85
1.5 HY 250 MA 72 OHM	1.25
3 HY 250 MA 15 OHM	1.65
15 HY 250 MA 60 OHM	2.95
5-14 HY 200 MA 80 OHM SW CH	5.60
8 HY 300 MA 500 OHM	5.55

OIL CAPACITORS

7 MF 330 VAC	$0.95	4 MF 1.5 KV DC	$2.49
3 MF 600 VDC	.45	6 MF 1.5 KV DC	2.95
2 MF 600 VDC	.59	1 MF 2000 VDC	.79
4 MF 600 VDC	.79	2 MF 2000 VDC	.99
1 MF 600 VDC	.89	1 MF 2500 VDC	1.25
10 MF 600 VDC	1.10	2 MF 2000 VDC	2.45
1 MF 1KV WAX	.29	4 MF 2000 VDC	3.95
2 MF 1000 VDC	.90	8 MF 2000 VDC	6.95
4 MF 1000 VDC	1.70	25 MF 2000 VDC	14.45
10 MF 1KV DC	2.49	2 MF 4000 VDC	3.95
15 MF 1KV DC	2.95	3 MF 4000 VDC	4.75
1 MF 1.5 KV DC	1.25	5 MF 4000 VDC	6.95
2 MF 1.5 KV DC	1.45	1 MF 7500 VDC	.79

110V	Filament Transformers	60 CY
2.5 VCT 10 A. 10KV INSULATION		$3.98
2.5 VCT 5A. 2.5 KV INSULATION		2.10
2.5 V 15 A. 2.5 KV INSULATION		3.45
6.3 V 3.2 A		1.25
6.3 V 5 AMPS		1.95
6.3 V 12 AMPS		1.75
6.3 V 2 AMPS, 6.3V 2 AMPS		3.40
6.3 V 2A, 2.5 V 2 AMPS ea.		3.49
6.3 V 2A, 2.5 V 6 AMP HERM SEAL		3.49
2.5 VCT 10 A. 2.5 KV INSULATION		4.95

115V	Power Transformers	60 CY
240 VCT 50 MA		$1.95
350 VCT 50 MA, 6.3V 2A, 5V 2A		2.75
700 VCT 90 MA, 6.3V 4A, 5V 3A		2.98
610 VCT 160 MA, 6.3V 5A, 5V 3A		3.95
450 VCT 250 MA, 5V 4A		2.95
400 VCT 200 MA, 6.3V 4A, 5V 3A		6.50
700 VCT 200 MA, 6.3V 10A, 6.3V 9A, 5V 3A		8.50
500 VCT 300 MA, 6.3V 10.5A, 5V 6A, 5V 2A		8.50
350 V 100 MA, 22VCT 100 MA, 6.3V 2.5A, 2.5V 10A		2.49

25% Deposit with order, balance C.O.D.

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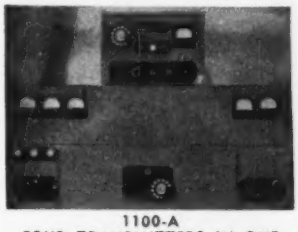
TELEVISION CAMERA

Just arrived! Fills a raft of vital TV uses. Block 3. 350-lines resolution. Easily converted to present R.M.A. standards. Circuits available with cameras.



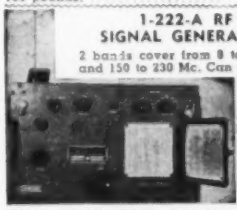
1100-A
FOUR TRANSMITTERS IN ONE

Can be present on 4 bands. Has BFO or xtal on each from 1.5 to 10 mcs. Oscillators are all between 1.5 and 5 mcs. 6L6 osc. VR-150 regulator, buffer or doubler is a 6L6 into 3-807's in parallel. 125 watts on phone and 125 watts on cw, modulator has 4-6L6's in push-pull parallel. Rig has telephone dial on front for selecting any one of 4 transmitters, selecting phone, CW, turning heaters on, plate current, or turning everything off. Also has remote control unit for remote operation. Used, but in excellent condition ..... with Remote $225.00

SCS-528 FM RECEIVER & XMTR: Complete with 80 xtals for operation in the 26-27.9 mcs. Powered by 12 or 24 VDC, with crystals, dynamotors, rack, mike, headset, mast base and section. Used but excel. cond.

RAYTHEON RECTICHARGER W-3155

Supply current at a constant voltage and supplies current to a storage battery, providing an automatic AC-DC power system: No moving parts: No adjustments: Life of the battery increases as much as 40%: Eliminates voltage variations. 11/12 cells, 22-24 volts at 3 amp. output: Input 95-130 volts, 60 cycles: Weight 180 pounds. $45.00



1-222-A RF SIGNAL GENERATOR

2 bands cover from 8 to 15 Mc., and 150 to 230 Mc. Can use up to the 3 harmonic; 110 V, 60 cycles built in power supply. New. $125.00

APS-4 COMPONENTS: Indicators, control boxes, junction boxes, 800-IC inverters, amplifier boxes, cords and plugs.

VARIAC TRANSTAT AMERTRAN

Input 0-115 V., 50-60 cycle; output 115 V 100 amps. 11.5 Kva. Excellent condition $75.00

COLUMBIA ELECTRONICS Ltd.

524 S. San Pedro St., Los Angeles 13, Cal.
Cable Address: COLELECT
25% deposit with order. Balance C.O.D.
All items subject to prior sale.

TEST EQUIPMENT

X BAND SPECTRUM ANALYZER, 8500-9600 MC, calibrated below cut-off attenuator, calibrated frequency meter, I.F. frequency 30 mc, bandwidth 50 kc, 110-250 V 60-800 cps.

S BAND SPECTRUM ANALYZER, 2700-3400 MC, similar to above.

TS-36/AP X BAND POWER METER.

TS-125/AP S BAND POWER METER.

X BAND BELOW CUT-OFF WAVE GUIDE ATTENUATOR, with calibrated dial and built in line stretcher, type N input connector, output connects to ½" x 1" wave guide..... $85.00

APR-1 or APR-4 RADAR SEARCH RECEIVER, 30 mc I.F., 2 mc wide.

TUNING UNITS FOR APR-1 or APR-4 RECEIVERS (can be used with any 30 mc amplifier):
TN-19, range 1000-2000 mc, tuned mixer cavity $150.00
TN-54, range 2000-4000 mc, tuned mixer cavity $150.00

30 MC I. F. STRIP AND 110 VOLT 60 cps POWER SUPPLY, bandwidth 10 mc, complete, new (part of APR-5 Receiver) $65.00

TS-45A/APM-3 SIGNAL GENERATOR, 9200-9600 mc, 110 V, 60-800 cps

TS-155A/UP S BAND SIGNAL GENERATOR, pulsed, calibrated output, 110 V, 60 cy., NEW

TS-56/AP SLOTTED LINE, slot length 16", tuned probe and meter $100.00

TS-35/AP X BAND SIGNAL GENERATOR, pulsed, calibrated power meter, frequency meter, 8700-9500 mc

TS-13/AP X BAND SIGNAL GENERATOR, pulsed, calibrated output, 110 V, 60 cycles

TPS-51PB/20 S BAND 20 db PAD $20.00

X BAND PICK-UP HORN $10.00

X BAND VSWR TEST SET TS-12/AP, complete with linear amplifier, direct reading VSWR meter, slotted waveguide with gear driven traveling probe, matched termination and various adapters, with carrying case. NEW. UNITS I AND II are available separtely or together as a test set.

S BAND SIGNAL GENERATOR CAVITY WITH CUT-OFF ATTENUATOR, 2300-2950 mc, 2C40 tube, with modulator chassis $30.00

HIGH PASS FILTER F-29/SPR-2, cuts off at 1000 mc and below; used for receivers above 1000 mc $12.00

UPN-1 S BAND BEACON RECEIVER-TRANSMITTER $75.00

S BAND TEST LOAD TPS-55P/BT, 50 ohms $8.00

X BAND TEST LOAD, 50 WATTS $35.00

250 WATT X BAND TEST LOAD, VSWR less than 1.15 between 7 and 10 KMC $150.00

LAF-1 SIGNAL GENERATOR, 100-600 mc, CW & pulse modulation, calibrated output, good condition, 110 v, 60 cps operation

GENERAL RADIO SIGNAL GENERATOR MODEL 522, 250-1000 mc, good operating condition.

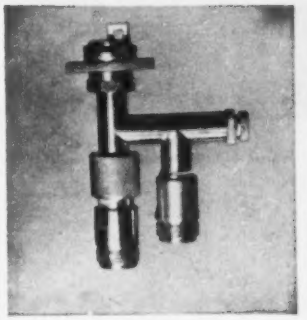
GENERAL RADIO PRECISION WAVEMETER TYPE 724A, range 16 kc to 50 mc, 0.25% accuracy, V.T.V.M. resonance indicator, complete with accessories & carrying case NEW.. $175.00

GENERAL RADIO SIGNAL GENERATOR 605-B, good working order $300.00

GENERAL RADIO VACUUM TUBE BRIDGE, Model 561D $275.00

FEDERAL RADIO 605-CS, 9 kc to 50 mc SIGNAL GENERATOR (JAN version of G. R. 605 $350.00

HEWLETT-PACKARD AUDIO SIGNAL GENERATOR 208A $230.00



S BAND CRYSTAL MIXER (illustrated), Variable Oscillator Injection $12.50

TBN-3EV THERMISTOR BRIDGE

S BAND THERMISTOR BRIDGE CU-60 ABU, Part of LZ Radar $60.00

RADIO RECEIVER BC-967T2, 18-160 mc, 3 bands, FM/AM, 110 V, 60 cps $200.00

MEASUREMENTS 78E, 50-75 mc, calibrated output $100.00

FERRIS MODEL 22A SIGNAL GENERATOR, 85 kc to 25 mc. Output .2 microvolts to 1 volt, modulation variable, good working order $175.00

FERRIS MODEL 10B SIGNAL GENERATOR, 85 kc to 25 mc, calibrated output, good working order $100.00

STANDARD SIGNAL GENERATOR MEASUREMENTS 65B, 100 kc to 30 mc, 1-2,000,000 microvolts, good working order $400.00

LABORATORY RECTIFIER, SYLVANIA 541-A, 3500 volts at 2 amperes DC output.

LB-3 LIMIT BRIDGE, Industrial Products $60.00

SIGNAL GENERATOR, 1-72-K, 100 kc to 32 mc, output not calibrated, 110 V, 60 cps... ... $35.00

AUDIO OSCILLATOR, HICKOK 198, RC tuned, 20-20000 cps $45.00

TEST SET TS-278/AP FOR AN/APS-13, synchronized, delayed pulse signal generator, 400-440 mc, calibrated waveguide below cutoff attenuator, synchronized marker generator, 115 V., 60 cps. NEW, COMPLETE $150.00

CLOUGH, BRENGLE RESISTANCE CAPACITY BRIDGE, model 230A, new $50.00

FIXED ATTENUATOR PADS, 20 db + 0 — 2 db, DC-1200 mc, 50 ohms, VSWR 1.3 or less, 2 watts average power $30.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR, type N connectors, rack and pinion drive, attenuation variable 120 decibels, calibrated 20-120 db, frequency range 2600-3600 mc $32.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR, similar to above except upper frequency limit is 3300 mc $32.00

WAVEGUIDE BELOW CUT-OFF ATTENUATOR, same as above except input is matched in range of 2200-3300 mc, VSWR less than 1.2 ... $54.00

PULSE INPUT TRANSFORMER, permalloy core, 50 to 4000 kc impedance ratio 120 to 2350 ohms $3.00

PULSE TRANSFORMER, UTAH 9230 ..... $1.50

PULSE TRANSFORMER, 133-AWF $6.00

PULSE TRANSFORMER, GE 68Q, 8286-1 ... $8.00

TS-10/AP CALIBRATED DELAY FOR APN-1, $25.00

TS-203/AP CALIBRATED SELSYN $10.00

UG-27/U TYPE N RIGHT ANGLE ADAPTERS 10 for $5.00; 1000 for $250.00

SD-3 SHIPBOARD RADAR, New and complete with test equipment..... $1050.00

SQ RADAR, used but in good working order, complete with antenna, control unit..... $650.00

SN RADAR, used, good working order, complete $350.00

HYPERSIL CORE CHOKE, 1 Henry, Westinghouse L-422031 or L-422032 ..... $3.00

PULSE FORMING NETWORK, 20 kv, .02 microsecond, 50 ohms, 800 p.p.s. $40.00

ANCHOR SCREWS from AB20CR Mast Equipment ..... $2.00 each

ELECTRO IMPULSE LABORATORY

P. O. Box 250 *Eatontown 3-0768* **Red Bank, N. J.**

SPECIAL
5—5 mfd—400 vdc Oil Cond.

3 terms, hot mtg flanged type. Dimensions 3⅝ x 3⅝ x 2. Tested at 1000 V. Meets commercial specs. for 600 Volt operation up to 40 degrees C. Being used as power factor correction capacitors. Numerous applications. 24 per carton. See symbol "F". Price ..... **$.39** each

OIL CONDENSER—New

Symbol	Cap.	Voltage	Type	Price
B	005-.005-.01	10 KV	26F344	2.50
I	.007	1,000V	Rev. hit	.08
E	.03	16KV	26F380	3.00
B	1	1,500V		.22
G	1	2,000V		.32
F	1	2,500V	#2516CB	.45
G	1	3,500V		.55
B	1	5,000V		.75
B	1	7,000V	#25F744	1.00
G	1	7,000V	Can 1 Term.	.90
B	1	7,500V	#23F447	1.20
B	1	10KV	#23F644	4.25
B	1	15KV	#25F572	5.25
B	2	10KV	#25F433	4.50
B	2.5	3,000V		1.15
E	2.5	6,000V	#23F659	1.75
B	25	20KV		16.95
B	3	2,000V		.49
B	4	10KV	#14F267	4.75
D	5	400V	#416MCT	.12
D	5	500V	#8CE6A3	.14
B	5	1,500V	Can	.25
B	5	2,000V		.75
B	5	3,000V		1.10
B	5-.5	600V		.20
B	7.5	1,000V		.17
F	1	400V		.16
D	1	500V	#23F266	.18
F	1	500V	#23F225	.18
F	1	600V	CP6881EP105	.24
B	1	600V		.20
B	1	1,000V	TJU10010G	.25
B	1	2,500V		1.15
B	1	10KV	#14F267	12.95
B	1	15KV		15.75
B	1.25-1.25	7,500V	#23F360	5.75
G	2	600V		.25
G	2	600V	TLA Type	.16
G	2	1,000V	TLA Type	.40
B	2	1,000V		.49
B	2	5,000V	Bkte	2.15
B	2	4,000V	#23F47G2	3.65
B	3	600V	Can	.25
B	4	4,000V		4.50
B	4	600V	#23F317	.60
B	5	600V		.52
E	5-5	400V		.38
B	6	2,000V		2.90
B	10	600V		.85
B	10	1,000V		1.95
B	15	1,000V	TJU10150	2.15

NEW MICA CONDS.

5, 15, 25, 30, 39, 75, 100, 140, 150, 185, 200, 250, 330, 450, 500, 550, 600, 700, 1000, 1250, 1400, 1500, 2000, 2800, 4700, 5000, 8000 and 10,000 mmfd @ 500V. $3.50 per "C". Special, 100 assorted $2.95.

NEW S. MICA CONDS.

10, 20, 50, 80, 100, 120, 140, 150, 200, 240, 250, 300, 345, 400, 500, 670, 1000, 1800, 2000 and 2500 mmfd @ 500V. $7.00 per "C". Special, 100 assorted $5.95.

MOLDED PAPER CONDS.

.004, .01, .02, .05 mfd—600V ..... $3.50 per "C"
.006, .01, .02, .05 mfd—400V ..... $2.50 per "C"

TYPE "J" POTS
$.35

Symbols: LS—Locking Type Shaft. S—Screwdriver. R—Round Shaft.

Ohms	Shaft	Ohms	Shaft
50	1-4S	25,000	1-SLS
200	1-8S	50,000	1-4S
500	1-8S	50,000	1-8S
500	1-2R	50,000	1-1-4R
1,000	1-SLS	50,000	1-SLS
2,000	1-SLS	100,000	1-SLS
3,000	1-SLS	100,000	1-4R
5,000	1-2R	100,000	1-4S
5,000	1-SLS	150,000	2-1-8R
5,000	1-4R	200,000	1-SLS
10,000	1-SLS	200,000	1-2S
10,000	3-8R	250,000	1-SLS
15,000	1-8S	250,000	1-8S
16,000	1-1-SLS	300,000 (2 Terms)	1-8S
20,000	1-SLS	1 Meg	1-SLS
20,000	1-1-4R	1 Meg	1-8S

TYPE "JJ"
$.70

Ohms	Shaft	Ohms	Shaft
1,000	1-4R	100K	1-2LS
1K-5K	3-8R	100K	31-SLS

Available in other sizes

COAXIAL CONNECTORS

UG-10-U	.85	UG-30-U	.90	UG-201-U	.85
UG-12-U	.59	UG-80-U		UG-245-U	.59
UG-21-U	.59	Special	.90	UG-266-U	.59
UG-22-U	.59	UG-58-U	.56	PL54	.10
UG-23-U	.59	UG-83-U	.59	PL81	.10
UG-24-U	.59	UG-83-U	.59	83-1R	.28
UG-25-U	.59	UG-88-U	.98	83-1SP	.28
UG-27-U	.59	UG-167-U	1.75	83-1SPN	.28
UG-29-U	.65	UG-190-U	.85		
AN-3102-14S-5P			.25		
AN-3102-14S-2P			.25		
RC-10066-201P			.25		

TUBE—BRAND NEW

3C24	.24	9006	.15	12SN7	.50
12C8	.35	872A	1.00	832-A	3.95
954	.15	836	2.25		
CK1006	.35	1616	.50		

CERAMICON CONDS.

10, 50, 100, 250, 500, 1000 & 5000 mmfd $4.00 per "C"

METAL TUBULAR OIL CONDS.

.02 & .05 mfd .400V ..... $5.00 per "C"
1 mfd—1000V ..... $6.00 per "C"

BATHTUB COND. SPECIALS

Cap.	Voltage	Terminals	Price
1 mfd	600V	ST	.10
.25 mfd	400V	ST	.10
2x.1 mfd	400V	TT	.10
2x.1 mfd	400V	BT	.10
3x.1 mfd	400V	ST	.15
2x.1 mfd	1,000V	ST	.19
1 mfd	400V	ST	.15
.5 mfd	400V	ST	.10

See Mar. edition for complete listing

55' STEEL MAST

Comprising 11 interlocking 5 foot sections, diameter 2" x 1-16" wall. Base mounting, 4 guy rings. Total weight 310 lbs. Price $18.00. Separately—Individual sections $2.00; base mounting $8.00.

Price F.O.B., 25% with order. Balance C.O.D. Minimum order $2.00.

MONMOUTH RADIO LABORATORIES

BOX 159 — OAKHURST, N. J.

SPECIAL PURCHASE . . . . BAKELITE PANELS!!!!

These are very handy to have around the shop. Can be used for panels, insulators and many other applications. Easy to cut to desired size and shape. (All have fabric base except #B034 which is masonite die-stock).

Stock No.	Size	Net Wt.	Pr. Ea.	Per 10	Per 100
B564	5 64X6"X18-1 9"	5 Oz.	15	1.35	11.00
B058	5 8"X5-1 9"X19"	9 Lb.	40	3.40	30.00
Bo34	3 4"X6"X14"	4 Lb.	80	6.80	60.00
Bo78	7 8"X6-3 4"X	5 Lb.	1.00	8.50	75.00

Write for free circulars showing bargains in tubes, condensers, TV equipment, transformers and many other items.

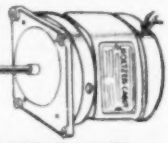
Terms: Cash with order or 25% deposit on C.O.D. orders. Net 10 days to rated concerns. All shipments F.O.B. Chicago, Ill.

IRVING JOSEPH RADIO PARTS, INC.

215 S. HALSTED ST. — CHICAGO, ILL.

NEW HOLTZER-CABOT TOTALLY ENCLOSED MOTORS

50 R.P.M. Reversible Single Phase Capacitor-Run type. 115 Volts AC 60 cycle 0.5 Amp. Torque 100 oz. inches. ⅜" shaft ⅝" dia. 400 at $16.50 ea. SAMPLE $17.50



GRAIN OF WHEAT LAMPS

Used for illuminating meters, compass dials, airplane instruments, etc. Soldering iron removes lamp from base to use in models, doll houses, miniature trains, Xmas trees, etc.
Mazda G.E. 321 Mazda G.E. 328
3V. 1/8 A. 6V. 2A.
Either type, doz. **$1.50**

MARKTIME 5 HOUR SWITCH

A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this special PRICE **$3.90**

Also available in 15 min. 30 min. 1 hr. at $8.50

ISOLATION TRANSFORMER $1.95

Nat. Known Mfgrs. 50 watt 2 windings 115 V. to 115 V. 60 cy. Ideal to prevent shocks from small radios and medical and electronic devices. Shipping Weight 5 lbs.
Other sizes and 220/110 in stock.

Kilowatt Demand Meter Totalizer containing heavy duty TELECHRON B.T., 1 RPM motor and hundreds of watch size gears, clutches, springs, etc. Shipping weight 2 lbs.
5 for $10.00 **$2.50**

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Write for Sizes and Weights.
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CRYSTAL DIODE IN 23 ..... .55
INSTANT REVERSIBLE 50 RPM SMALL 12V. DC-40 OHM RELAY ..... 5 for $1.00
Sample 50¢
ALLIANCE OR RUSSELL 110V AC MOTOR $1.85; 3 for $5.00

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CFT—47372

We are Authorized Wholesalers for Micro Switch Corp. and carry the largest stock of Allen-Bradley Solenoids, Potter & Brumfield Relays, Guardian Electric Co. Solenoids and Relays and Hayden Clock Motors in all speeds. Electric Counters.

EST. 1923 **BLAN** EST. 1923

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64 Dey St., New York 7, N. Y.

WANTED

(Additional Wanted Ads on opposite page)

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Write Condition and Prices

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- Audio Oscillator
- Panoramic Audio Analyzer
- Wave Form Analyzer

W-6309, Electronics
330 W. 42nd St., New York 18, N. Y.

WANTED

Boonton 160A, 170A Q Meter; GR916A RF bridge, GR 736A Wave Analyzer

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330 W. 42nd St., New York 18, N. Y.

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Large and small quantities of new or used electronic government or manufacturers' surplus tubes and equipment. Highest prices paid. State quantity, condition and best price in first letter.

W-2369, Electronics
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$ CASH PAID $

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Boston 10, Mass.

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BC 639 } RECEIVERS - - Original condition

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500 FRELINGHUYSEN AVENUE
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WANTED
TEST EQUIPMENT
state asking price, age and condition in first letter.

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330 W. 42nd St., New York 18, N. Y.

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WESTERN ELECTRIC VACUUM TUBES
Types 101F, 102F, 272A, 274A or B, 310A or B, 311A, 313C, 323A, 328A, 329A, 348A, 349A, 352A, 373A, 374A, 393A, 394A, 131A Ballast Lamps.
W-6641, Electronics
330 West 42nd St., New York 18, N. Y.

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Teletypewriters complete, components or parts. Any quantity and condition.

W-6654, Electronics
330 West 42nd Street, New York 18, N. Y.

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STANDARD AND SILVER MICAS
Postage stamp and half postage stamp size.
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RANGE TO 1000 MMFDS.
General Radio, Western Electric, or Equivalent
W-6224, Electronics
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any ohmage
any tolerance

We pay highest prices

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POWER RHEOSTATS

Ohms	watt	ea.	Ohms	watt	ea.
2	225	$4.95	150	150	$3.50
2	100	2.70	200	25	.98
3	225	4.95	200	150	3.50
4	225	4.95	225	50	1.24
5	50	1.24	250	25	.98
5	100	2.70	250	150	3.50
5	150	3.50	350	100	2.70
6	25	.98	375	150	3.50
6	50	1.24	400	25	.98
7	25	.98	500	25	.98
8	50	1.24	500	75	2.49
10	25	.98	500	150	3.50
10	100	2.70	750	25	.98
12	25	.98	750	150	3.50
15	25	.98	1000	25	.98
20	50	1.24	1200	225	4.95
22	50	1.24	1250	50	1.24
25	25	.98	1250	150	3.50
32	300	8.25	1500	50	1.24
50	25	.98	2000	25	.98
50	50	1.24	2000	50	1.24
50	750	17.95	2500	100	2.90
60	25	.98	3000	25	.98
75	150	3.50	3000	100	2.90
80	50	1.24	3500	50	1.24
80	300	7.60	5000	25	.98
100	25	.98	5000	50	1.49
100	50	1.24	7500	50	1.63
100	225	2.70	7500	100	3.30
125	25	.98	10000	50	1.63
125	300	7.60	10000	100	3.50
150	50	1.24	20000	150	5.26

Specify whether shaft required is KNOB or SCREWDRIVER type
(Discount to Quantity Users)

SELECTOR SWITCHES

Pole	Pos.	Deck	Type	Each
1	6	1	bak-shtg	.51
1	12	1	cer-n. shtg	.55
1	24	1	bak-n. shtg	.69
1	24	2	bak-n. shtg	.79
2	2	1	cer-shtg	.39
2	6	2	bak-n. shtg	.69
2	6	3	bak-shtg	.54
2	11	2	bak-shtg	.60
4	4	2	cer-n. shtg	.54
4	11	4	bak-shtg	1.20
5	3	2	cer-n. shtg	.56
6	11	6	bak-n. shtg	1.98
10	5	5	cer-shtg	1.49
12	2	3	bak-shtg	.54
16	2	4	bak-n/shtg	.98

"AN" CONNECTORS

LARGE VARIETY AVAILABLE AT GREAT SAVINGS

Send your specs and let us quote

BIRTCHER TUBE CLAMPS

#926-A	14¢ ea.	#926-B22
#926-A1		#926-C
#926-B	$12.00	#926-C1
#926-B1		#926-C5
#926-B2	per hundred	#926-C10
#926-B7		#926-C24

OIL CONDENSERS

Mfd	VDCW	Each
1	3000	.75
1	6000	1.89
1	20,000	18.95
.25	5000	1.10
.5	1500	.89
1	600	.35
1	2000	1.95
2	600	.35
2	600	.39
2	1000	.79
4	600	.69
4	600	.75
6	600	.79
10	600	.98
14	600	1.25
15	600	1.98
15	1000	3.25
2 x 1	2000	3.95
2 x .5	3000	14.95

BATHTUBS

mfd	vdcw	each
.015	400	.17
.05	200	.17
.05	400	.19
.05	600	.21
.1	400	.20
.1	600	.22
.1	1000	.32
.15	600	.22
.25	200	.19
.25	600	.23
.35	400	.22
.5	400	.23
.5	600	.25
.5	1000	.35
1	200	.29
1	600	.35
2	400	.44
2	600	.59
4	50	.25
8	500	.59
.25	50	.28
.25	75	.30
.50	25	.27
.50	25	.28
200	12	.35
300	6	.39
.05-.05	600	.29
.05-.05	1500	.45
.1-.05	200	.25
.1-.1	400	.26
.1-.1	600	.28
.16-.16	600	.28
.2-.2	600	.29
.25-.25	600	.30
.5-.5	600	.35
1.0-.1	300	.29
200-200	9	.49
1 x .05	600	.40
1 x 1	400	.42
1 x 1	600	.45
3 x .25	600	.50
3 x 1.0	100	.40

Specify Top, Side, or Bottom Lugs.

"UG" Connectors

UG-12/U	$ .89
UG-13/U	1.49
UG-18/U	.89
UG-19/U	1.15
UG-21/U	.89
UG-22/U	.95
UG-23/U	.98
UG-25/U	1.15
UG-27/U	1.25
UG-57/U	.89
UG-58/U	.65

TYPE "J" POTENTIOMETERS

Specify whether regular or screwdriver shaft is required.

TYPE "J" 50c

ohms	ohms	ohms
50	2000	20K
100	2100	25K
150	2200	30K
200	4000	50K
400	4700	75K
500	5000	80K
600	10K	100K
1000	11K	200K
1200	12K	250K
1400	15K	300K
1500	16K	1meg

When ordering locking type bushings, locking nuts are available in the following types:

Hex shaft lock @ .05
Acorn " " @ .10
Knurled " " @ .10

TYPE "JJ" $1.25

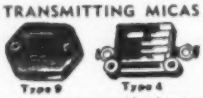
ohms	ohms
100-100	100K-100K
200-200	150K-150K
500-500	250K-250K
600-600	200K-200K
1500-1500	250K-250K
2000-2000	300K-300K
5000-5000	350K-5000
10K-10K	350K-25K
20K-2000	500K-500K
25K-16K	500K-75K
35K-5000	1meg-1meg
50K-50K	5meg-5meg

TYPE "JJJ" $2.25

ohms

20K-200K-20K
45K-27K-2500
700K-700K-700K
750K-750K-750K
500K-500K-500K
1meg-1meg-1meg

TRANSMITTING MICAS



Type 9 Type 4

mfd	vdcw	type	ea.	mfd	vdcw	type	ea.
.00001	600	4	.18	.00162	600	4	.18
.00003	600	4	.18	.002	600	4	.20
.00005	600	4	.18	.002	1200	4	.65
.00005	2500	9	.31	.0022	2500	9	.78
.0001	600	4	.18	.0025	600	4	.23
.0001	2500	9	.31	.003	600	4	.25
.000152	600	4	.18	.0049	600	4	.25
.0002	600	4	.18	.005	600	4	.25
.00025	600	4	.18	.005	1200	9	.69
.0005	600	4	.18	.005	2500	9	1.18
.00051	2500	9	.43	.0062	600	4	.30
.0007	600	4	.18	.01	600	4	.44
.0008	600	4	.18	.01	600	9	.49
.0009	600	4	.18	.01	1200	9	.98
.001	600	4	.18	.0142	600	4	.45
.001	1200	4	.31	.02	600	4	.56
.001	1200	9	.31	.02	1250	9	1.36
.0015	600	4	.18	.027	600	4	.66
.0015	600	4	.18	.043	600	4	.99

"UHF" Coax Cable CONNECTORS

83-1AP 83-1AP 83-1SP

Cat. No.	Army No.	Type	Each	Per C
83-1AP	M-359	Plug	.35	.28
83-1D	PL-271	Adap	1.25	1.00
83-1F	PL-274	Feed	1.10	.90
83-1R	SO-239	Rec.	.35	.28
83-1SPN	PL-259A	Plug	.35	.28
83-22R	SO-264	Rec.	.50	.40
83-22SP	UG-102/U	Plug	.68	.60

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- FILTERS
- FUSES
- INVERTERS
- KLYSTRONS
- MAGNETRONS
- MAGNETS
- MICROPHONES
- METERS
- MOTORS
- POTENTIOMETERS
- POWER SUPPLIES
- PROJECTION LAMPS
- SELSYNS
- SCOPE ACCES.
- SHOCK MOUNTS
- SOCKETS
- SWITCHES
- TELEPHONE EQUIP.
- TEST EQUIPMENT
- TRANSFORMERS
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Dept. E-550

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PRECISION LEVEL — interior ground tube level with 4 adjusting screws. Overall length 1⅝", diam. 15/32". One end with shoulder ⅛" diam. $.85

DELCO BLOWER — sirocco type D.C. Flange diameter 2⅝" blade 3-3/16" RPM @ 12 volts 2400 RPM @ 6 volts 1600 ..... $3.95

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GLASS VIAL — to use as a permanent level on equipment $1.00

Miniature lamp T1¾. 3 volt .13 amp. Airplane Indicator, Arch. Ltd.
10 for ..... .85
100 for $7.50

Lamp Assembly C203 Genl. Made by Eastman Kodak with Iris Diaphragm. 32 volt lamp ..... each $1.95

DETROIT THERMOSTATIC EXPANSION VALVES #874-494 3-5 Inlet, 1-2" S.A.E. Outlet, 7-32" Orifice for use with FREON. Maximum Operation 55 lbs. $4.50

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55 VAC DPDT. Operates on 12 VDC or 110 VAC. Intermit. duty (5 min.). 2 units in series for 110 VAC for 4PDT oper. #R211 $1.10 ea.
BO-6D29 6 VDC DPDT 16.5 ohms. #R213 $1.10 ea.
BOX-102 24 VDC DPDT 250 ohms. #R04 $.89 ea.
BO-13D35 24 VDC 8PST NO (Mic) to 250 ohms. #R06 $.79 ea.

Over 100,000 Relays in Our VAST STOCK

GUARANTEED—IMMEDIATE DELIVERY
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G. E. CR9533K100A2 260 ohm 24 VDC DPST N.C. & SPST n.o. 2 switchettes. Extra Long throw. #R138 ..... $2.40
HART M569A CAT 2 #9R19 75 ohm 24 VDC 20% susp. cont. SPST n.o. #R127A $1.75

SINE - COSINE - SQUARE - WAVE POTENTIOMETER W.E. CO. #1 D89100 for very low freq. sweep circuits $9.95 ea.

S.S. WHITE DENTAL LAB RESISTORS 1K, 4K, 60K, 100K, 500K All 1 Watt $7.50/C

H-F TIE POST

LOW LOSS BAKELITE INSULATION
$7.50/C $67.00/M

LARGE STOCKS OF AN Connectors, APC's, Binding Posts, Cable, Capacitors, Ceramicons, Ceramics, Chokes, Circuit Breakers, Coils, Controls, Crystals, Filters, Fuses, Hardware, Knobs, Relays, Resistors, Shock Mounts, Sockets, Spaghetti, Switches, Transformers, Tubes

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SAVE $180!

BANISH FOREVER HOT DAYS! NIGHTS!

VARIABLE ELECTRIC
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USES NO WATER

FOR COOL—CLEAN AIR
WINTER & SUMMER

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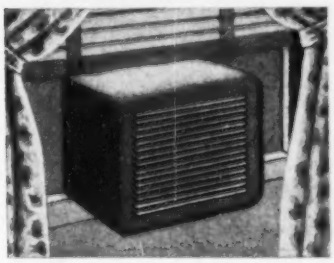

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Continuous Variable Control

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PERFECT VENTILATION. Air filtration is assured by use of PATENTED FILTER for ELIMINATING DUST, DIRT, and POLLEN from outdoors.

Ventilates your room with CLEAN, COOL, FILTERED AIR . . . SUMMER or WINTER. Enables you to SUBDUE outside NOISES by keeping windows closed and to get the amount of air you want, whether calm or stormy.

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110V 60 Cycle AC **$44.95** F.O.B. N.Y.C.

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110 V.D.C.	59.95
220-230 V.A.C.	$59.95

(Plus 10% U. S. Excise Tax)

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SINGLE PHASE FULL WAVE BRIDGE RECTIFIERS

Input 0-115VAC		Output 0-12 VDC
Type No.	Current	Price
B1-250	250 MA.	$0.95
B1-1	1 AMP.	2.49
B1-1X5	1.5 AMP.	2.95
B1-3X5	3.5 AMP.	4.50
B1-5	5 AMP.	6.95
B1-10	10 AMP.	9.95
B1-20	20 AMP.	15.95
B1-30	30 AMP.	24.95
B1-40	40 AMP.	27.95
B1-50	50 AMP.	32.95

Input 0-36VAC		Output 0-26 VDC
Type No.	Current	Price
B2-150	150 MA.	$0.99
B2-250	250 MA.	1.25
B2-300	300 MA.	1.50
B2-2	2 AMP.	4.95
B2-3X5	3.5 AMP.	6.95
B2-5	5 AMP.	9.95
B2-10	10 AMP.	15.95
B2-20	20 AMP.	27.95
B2-30	30 AMP.	36.95
B2-40	40 AMP.	44.95

Input 0-115VAC		Output 0-90 VDC
Type No.	Current	Price
B6-250	250 MA.	$2.95
B6-600	600 MA.	5.95
B6-750	750 MA.	6.95
B6-1X5	1.5 AMP.	10.95
B6-3X5	3.5 AMP.	18.95
B6-5	5 AMP.	24.95
B6-10	10 AMP.	36.95
B6-15	15 AMP.	54.95

THREE PHASE FULL WAVE BRIDGE RECTIFIERS

Input 0-234VAC		Output 0-250 VDC
Type No.	Current	Price
3B13-1	1 AMP.	$22.00
3B13-2	2 AMP.	32.00
3B13-4	4 AMP.	56.00
3B13-6	6 AMP.	81.50
3B13-10	10 AMP.	105.00
3B13-15	15 AMP.	120.00

CENTER TAPPED RECTIFIERS SINGLE PHASE FULL WAVE

Input 10-0-10VAC		Output 0-8 VDC
Type No.	Current	Price
C1-10	10 AMP.	$6.95
C1-20	20 AMP.	10.95
C1-30	30 AMP.	14.95
C1-40	40 AMP.	17.95
C1-50	50 AMP.	20.95

RECTIFIER MOUNTING BRACKETS

For Types B1 through B6, and
Type C1 ..... $ .35 per set
For Types 3B ..... 1.05 per set

SELENIUM RECTIFIER CATALOG

Write for our Catalog No. 719 which lists Selenium Rectifiers, associated transformers, condensers and filter chokes.

Minimum order $3.00. No C.O.D.'s. Add 10% for Prepaid Parcel Post and Handling. Terms: Net 10 days in the presence of approved credit.

All prices subject to change without notice. *Prices and Delivery F.O.B. our NYC Warehouse. All merchandise subject to prior sale.*

POWER SUPPLY KITS
24 to 28 VDC Filtered

Designed for continuous duty ground operation and bench testing of aircraft equipment, these kits provide a reliable means of obtaining a source of low ripple 24 VDC, from a 115 VAC 60 cycle line. Full wave bridge Selenium Rectifiers insure instantaneous and efficient operation. Adjustment of the DC output voltage is accomplished by transformer primary taps. Ripple is limited to within 2% of the average DC output by choke-input filters.

Kit No.	Amperes DC	Net Price
242	2.0	$16.39
245	5.0	22.39
2410	10.0	47.44
2420	20.0	79.44

Write for descriptive Bulletin No. 201

RECTIFIER CAPACITORS

CF-14	3000 MFD	12VDC	$1.69
CF-15	6000 MFD	12VDC	2.95
CF-1	1000 MFD	15VDC	.99
CF-2	2000 MFD	15VDC	1.69
CF-20	2500 MFD	15VDC	1.95
CF-3	1000 MFD	25VDC	1.25
CF-4	2X2500 MFD	25VDC	3.45
CF-6	4000 MFD	30VDC	3.25
CF-7	3000 MFD	35VDC	3.25
CF-8	100 MFD	50VDC	.98
CF-19	500 MFD	50VDC	1.95
CF-18	2000 MFD	50VDC	3.25
CF-21	1200 MFD	90VDC	3.25
CF-9	200 MFD	150VDC	1.69
CF-10	500 MFD	200VDC	3.25

Mounting clamps for above capacitors ..... 15c ea.

RECTIFIER TRANSFORMERS
All Primaries 115VAC 50-60 Cycles

Type No.	Volts	Amps.	Shpg. Wt.	Price
XF15-12	15	12	7 lbs.	$3.95
TXF36-2	36	2	6 lbs.	3.95
TXF36-5	36	5	8 lbs.	4.98
TXF36-10	36	10	12 lbs.	7.95
TXF36-15	36	15	20 lbs.	11.95
TXF36-20	36	20	30 lbs.	17.95
XFC18-14 18VCT		14	10 lbs.	5.95

All TXF Types are Tapped to Deliver 32, 34, 36 Volts. XFC Type is Tapped to Deliver 16, 17, 18 Volts Center Tapped.

RECTIFIER CHOKES

Type No.	Hy.	Amps.	Dc Res.	Price
HY5	.02	5	.25	$3.25
HY5A	.0228	6	.203	3.95
HY10	.02	10	.30	9.95
HY10A	.014	10	.04	7.95
HY20A	.007	20	.02	12.95

Type "A" low resistance chokes are specially suited to circuits requiring excellent voltage regulation.

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Attractive, rugged, and reasonably priced. Moving vane solenoid type with accuracy within 5%.

0-6 Amperes D-C
0-12 Amperes D-C
0-15 Volts D-C
Any range $2.49 each

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RAYTHEON MFG. CO.
Surplus Sales Dept., Waltham, Mass.
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0-200 ua 3" sq. G.E. DO 50	$ 8.00
0-100 ua 3" sq. G.E. DO 50	10.00
0-50 ua 3" sq. G.E. DO 50	12.00

R.F. MILLIAMMETERS

0-115 Ma 3½" Weston 425	$12.00
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PRECISION PORTABLE INSTRUMENTS
Single or multi-range

D.C. Microammeters, from 5 ua full scale. Thermo-couple Milliammeters, from 1.5 Ma. Thermo-couple voltmeters.

Precision Electrical Instrument Co.
146 Grand Street New York 13, N. Y.

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TV EXPERIMENTERS!

RADAR SEARCH RECEIVER ARD-2
80 TO 3000 MCS

The requests for technical information on the ARD-2 equipment, have been overwhelming, to the point that we are describing it more fully below to further assist you.

MADE FOR: US Navy patrol aircraft. **PURPOSE:** To measure carrier frequencies from 80 to 3000 MCS and pulse rates from 50 to 8000 cycles per second. Signals can be located by calibrated charts.

EQUIPMENT: Consists of the following: 1 ANTENNA-DETECTOR (CMD-60AFH) has variable length antennas (2), diode detector, and silver plated tuning stub with calibrated scale; 1 AMPLIFIER (CMD-50AIDC) has three stage pulse amplifier, a trigger circuit, a pulse rate counter circuit and audio amplifier, a visual signal indicator, and a rectifier power supply which is operative on 115 Volts AC, single phase, at 60 to 2400 cycle current, regulated; 1 TEST OSCILLATOR (CMD-60AIBG) has carrier frequency of 400 cycles with selection of four pulse repetition rates.

With the above are included all cables with fittings, accessories, and shock mounted rack, a steel chest with complete spare parts and 200% additional tubes and 2 technical manuals. Gross weight 113 pounds.

BRAND NEW! ORIGINAL PACKING! COMPLETE!
Price, each $175.00

RECEIVER-TRANSMITTER COMBINATIONS

SCR-508, 528 FM or AM. 15 Watts output; 20.0-27.9 Mcs., complete with receiver and transmitter, dynamotors, control boxes, crystals, antennas.

SCR-608, 628 as above, except for frequency of 27.0-38.9 Mcs.

TCS Mfged by Collins 40-50 W. Phone & CW for 12 V. DC, 1.5 to 12.0 Mcs. with all accessories.

AVT RCA Mfged by RCA, 8-10 Watts phone and CW, 2300 to 6700 Kcs. Small compact for 6 & 12 V.D.C. NEW & COMPLETE with power supply, mike, key & antenna.

TRANSMITTERS

BC-610 Hallicrafter. 2.0-18.0 mcs. 450 watts CW, 350 watts phone. Antenna tuner & speech amplifier, cables, manuals, complete. Wt: 446 lbs net.

BC-365 Federal Tel. & Tel. 156 to 456 Kcs. 150 watts CW for Radio Range or carrier communication. Complete. Wt: 629 lbs net.

BC-325 Federal Tel. & Tel., 1.5-18.0 Mcs. 400 W. phone 600 W. CW, complete with remote control. Wt: 900 lbs net.

TDE Westinghouse Mfg. 300 to 18,100 Kcs. 125 W. A1; 35 W. A2 A3; for naval or shore use. Complete in several input voltages. Wt: 672 lbs net.

Western Electric WE-34A; RCA, ET-3619; Westinghouse TCE; and others.

MOBILE EQUIPMENT

For 6 Volt DC operation, in 30 to 40 Megacycle band. Receivers and transmitters mfged by RCA, LINK, Motorola, NEW.

TAPE FACSIMILE EQUIPMENT

Model RC-58-B with transmit messages, handwritten or typed on a paper tape by direct wire or via radio. Complete with amplifier, recorder, scanner, accessories, and spares. NEW in one case.

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5 WATT, Model JT-32 by Jefferson-Travis, 2 channel, crystal controlled recvr-transmitter, built-in speaker, hand microphone, 6 Volt DC power supply. Freq: 2000-3000 KCS, in compact steel cabinet, complete less xtals. New in original cartons. In dealer quantities.
50 WATT, MTR-5032 by Harvey-Wells, SIX channel xtal controlled recvr-transmitter, 2000-3000 Kcs. with built-in speaker, telephone hand set, (provisions for selector-ringer and external deck calling system) in handsome steel cabinet for 32 Volt DC input. Complete, less crystals. NEW.
50 WATT, MTR-5011, as above, but for 115V Ac
75 WATT, MTR-7532, similar to above, with same features, for 32 Volts DC input.
75 WATT, MTR-7511, as above, but for 115 V. DC.
Other models in various wattages in stock. Dealer inquiries invited.

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DAS/DAS-2 Mfged. by General Electric Co. for US Navy. A shipboard installation requiring no modifications. For 115 and 230 V. AC input at 50-60 cycles. Has four channel selector. COMPLETE and BRAND NEW in one case. Price $395.00

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SN RADAR, Mfged. by Gen. Elec. Co. for US Navy portable use. An excellent 10 CM equipment self contained and complete with all accessories. Input: 110 V AC, (and 110 V DC—with generator included). Ranges on 5 & 25 mile scales on 5" scope. Complete accessories, complete equipment spares, 200% tube spares, cables. All complete & NEW.

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NEW YORK'S RADIO TUBE EXCHANGE

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
0A4G	$ .72	4B30	1.75	250TH	19.25	720DY	45.00	975A	12.50
0B	3.95	4C21	1.25	250TL	15.00	721A	2.60	991	.25
1B22	2.95	4C27	29.95	250R	5.95	722A	3.95	CK1005	.35
1B23	8.95	4C30	1.25	1B/253	6.95	723A	6.95	CK1006	.95
1B24	4.95	4C35	19.95	274B	1.75	723A/B	10.95	1250	.95
1B26	2.95	4J25	95.00	287A	3.95	724A	2.95	1611	1.50
1B35	19.95	4J26	95.00	CE301	3.95	724B	3.95	1613	.75
1B38	32.50	4J31	95.00	304TH	3.95	725A	12.95	1616	1.10
1B42	7.95	4J35	195.00	307A	4.25	726A	9.95	1619	.50
1B56	45.00	4J38	95.00	310A	4.50	726B	19.95	1622	1.50
1B60	45.00	4J50	195.00	316A	.69	726C	36.00	1624	.99
1N21	.85	4J52	250.00	350A	2.40	725AY	65.00	1625	.45
1N21A	.95	5BP1	2.75	350B	1.80	730A	6.95	1626	.45
1N21B	1.50	5BP4	1.95	368AS	2.40	801A	.69	1629	.45
1N23	.85	5C10	9.95	371B	.59	802	4.50	1631	.89
1N23A	.95	5CP1	1.95	388A	1.80	803	4.50	1641	1.00
1P21	3.75	5D21	19.95	393A	4.95	804	10.95	1851	1.10
2AP1	3.50	5F8	9.95	394A	4.95	805	6.95	1852	.99
2C25	.75	5FP7	1.95	417A	12.95	807	1.35	1853	.90
2C35	1.95	5JP1	45.00	434A	3.50	808	2.75	1854	.90
2C40	6.75	5JP2	10.95	450TL	37.50	809	2.75	2051	.55
2C43	12.50	5JP4	25.00	446A	.99	810	7.50	8012A	3.95
2C46	1.25	6CA	7.95	446B	1.80	811	2.15	8013A	2.75
2C51	7.50	6AC7	.99	WL468	5.95	813	7.95	8014A	25.00
2D21	1.05	6AG7W	1.75	WL469	2.75	814	2.95	8016	1.25
2J21	9.95	6AK5	1.10	WL525	2.75	815	1.50	852	9.95
2J22	9.95	6C21	19.95	527	7.95	827R	99.00	866	1.75
2J26	8.75	6F4	5.95	WL530	12.95	829B	7.50	861	19.95
2J27	9.75	6J4	4.95	WL531	7.95	832	3.95	866A	1.15
2J31	9.75	6-5	.95	WL532	2.95	832A	4.50	869B	39.95
2J32	12.95	6SU7GTY	1.25	533	39.95	834	7.50	872A	2.75
2J36	185.00	7HP7	4.95	WL535	7.75	836	1.10	874	1.95
2J38	7.95	7JP4	12.50	WL538	1.25	837	1.95	876	.75
2J40	25.00	10Y	.59	GL570	1.25	838	3.75	878	2.25
2J42	150.00	15E	1.50	575A	12.50	845	4.50	5819	1.75
2J49	24.50	15R	1.00	579B	5.95	849	19.95	8020	2.95
2J50	24.50	RX21	2.50	700A to B	19.50	851	19.95	8021	1.75
2J55	55.00	SC22	65.00	701A	3.95	854	1.45	8022	1.00
2J61	45.00	CV55	35.00	703A	2.40	885	1.25	8025	3.75
2J62	65.00	RK72	.95	705A	.75	931A	3.95	9001	.55
2K25	19.95	RK73	.95	707A	6.95	954	.45	9002	.55
2K28	19.95	OK22	249.00	707B	9.95	955	.45	9003	.55
2K29	24.95	OK45	55.00	710A	1.25	956	.45	9004	.45
2K45	on Request	OK59	59.00	715AY	4.95	957	.25	9005	1.50
2X2A	.69	OK61	49.50	715A	6.95	958A	.55	9006	.25
2V3G	.99	RK59	2.25	715B	9.95	959	.75		
2Y45	.29	RK49	2.40	715C	24.95				
3A4	.75	VR53	.29	717A	.95	350A is a long life WE807			
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3AP1	4.95	100TH	10.95	720BY	45.00	WE 701A can be used for a Super 813			
3BP1	3.95	VR105	.79	720CY	45.00				
3B24	1.50	E123A	8.95						
3C23	3.95	VR150	.65						
3C24	.95	VR95	19.95						
3C31	3.95	X99	.75						
3C45	13.95	203A	3.95						
3DP1A	3.25	211	.75						
3E29	7.50	217C	6.95						
3J31	59.95	242C	7.50						
4A1	.95	249C	3.75						

$10 Minimum Order

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K Band Spectrum Analyzer
X Band Spectrum Analyzer
X Band Signal Generator Types
TS 13 — TS 12 UNIT = 1 and 2
TS 16AA — TS 45
TS 33 — TS 146
TS 35 — TS 263
TS 36
X Band Magic T
X Band Crystal Tunable Mounts
RF 4 Echo Box S Band
S Band Signal Generators PE 102, BC 4277/60ABQI
S Band Power Meter

Oscilloscopes

TS 34
RC 1207A
Cossor Two Beam

Standard Broadcast and Short Wave Equipment

TS 69
Ferris 20B Microvolter
Rider 162C Chanalist
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RCA Audio Chanalist
Measurement Corp. 65 B Signal Gener.
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New Boxed Motor Generator Sets delivering 1200 W., at 480 cy. and 100 W. 28 V D.C. from 110 v., 220 V., 60 cy., to operate on the ground aircraft equipment.

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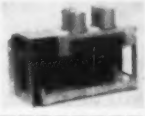
REMOTE CONTROL M2 AMPLIFIER 115 V. 60 Cy. Input. 2 channels of Class B Amp. Uses 1-5V4 & 4-6N7 Tubes. Has 4-1A57 Thordarson Bantam Audio Trans. Less Tubes .. **$8.75**



14 PIN T. V. SOCKET for 2BP1 & 7JP4, etc. Black Bakelite ..... **25¢** Mica Filled ..... **18¢**

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10 HY. @ 65 MA. ..$.97 10 HY. @ 110 MA. ..$1.40
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TG 10 KEYERS w. TUBES **$24.95**

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TRANSFORMER POWER SUPPLY 115 V. 60 Cy. 300 V. @ 55MA. 6.3 V. @ 2 Amps. Has 5Y3, 2-8 HY. Chokes, 2-30 MFD Filters, Pilot Assy., Term. Strip. Meas. 5" x 5" x 8". Completely wired **$6.85**

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U.H.F. SIGNAL GENERATOR Similar to BC-221 type 710A 220 to 560 Meg. Output 1 Microvolt to .09 Volts. 400 Cy. Int. Mod. Dial Cal. Directly in Meg. Cavity Tuner. Cal. Piston Atten. Ideal for Citizens Band **$145.00**

TRANSTATS—3.9 KVA 1 Phase 50/60 cy. fixed winding 115/230 V. output 0-260 V. Max amps 15 ..... **$42.00**

5.85 KVA 1 phase 50/60 cy. fixed winding 115/230 V. Output 0-260 V., Max amps 22.5 ..... **$52.00**

MEMOVOX AP-ERP1 RA-345 Constant Groove Speed 16" Portable Play Back Units, with Reproducer. Less Cutters Each **$125.00**

20 Meg. SLUG TUNED I.F. COIL in 1/16" solid copper can 1⅛" x 3" similar to type used on BC 406 35¢ ea. ..... 3/**$1.00**

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LARGE QUANTITY OF SEMI-PRECISION FACTORY TEST EQUIP. Pulse Gen. Pulse amp., Multi-Vib., Sig. Gen., Wavemeters, Delay lines, etc. Write requirements.

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EXTRA SPECIAL VALUES

LECTURE TYPE GALVANOMETER

- DC Galvano-Volt-Ammeter ● Scale 5-0-5
- Complete with shunts
- DIMENSIONS: 19" Lg. x 14½" H x 7½" W

Mfg'r Conco #62145
BRAND NEW—SPECIAL **$68.00**

Esterline-Angus Twin Chart Graph Recorder Model AWT-N Twin Flush Grnph DC Milliameter feeds hourly - ½" - 1½" - 3" - 6" - 12"

Minute ½" - 1½" - 3" - 6" Scale Range 2.5-0-2.5 MA Writing Door—Synchronous Clock on each meter — Chronograph pen on each meter. Complete with Pens, Filler, Graphic Meter, Ink Charts, etc.
Brand New **$450.00**

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The Hydromatic type Constant Speed Control is a self-contained governor which automatically brings about the adjustments in propeller blade pitch necessary to maintain constant engine speed under varying flight conditions.
BRAND NEW $49.50

Send your inquiries for aircraft hardware and radio equipment.

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Frequency Range 2000-18500 KC bearing indication—visual, phase comparison. Brand New Complete.

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CW transmission frequency range 2000-16000 KC. Pierce Crystal Oscillator. Model 1000 AG-CW Complete. Brand New.

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⅓ HP GE motor 115V 1 phase 60 cycle, 1725 RPM CW rotation —Assembly is 10¼" wide, 12" high —Air intake 6" dia.—Air output 4⅝" x 4⅝" Brand New $19.95

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50 watt tube socket 872, 211 .19

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24 VDC .220 Amp. Heine $0.49
110 VAC 3 Amp Curve 3 Heine ..... .69
115 VAC 4 Amp Curve 1 2 Pole 1.40
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SPECIALS
TRANSMITTING MICA AEROVOX

.0012 MFD 20,000 VDC Brand New $10.95

TIME DELAY LINE

1 micro second 15 KVA 400 cycle 50 ohm. Brand New $4.95

DE-ION LINE STARTER

DPST 115V 60 cy 15A 1 HP rating Westinghouse New $3.25

WESTON #666 SOCKET SELECTOR UNIT

Measures current, voltage, resistance, etc. In a vacuum tube circuit. Brand New $9.95

INERTEEN CAPACITOR

1.0 MFD 7500 VDC Brand new $5.25 ea./2 for $4.45 ea

FILTER REACTORS

.4 HY 4.5 amp DC 5 ohms 1230 RMS to ground test GE Brand New $30.00

1.7 HY with .02 amp DC and not less than 0.3 HY with 2 amp DC ripple. 9000 V. DC circuit. GE Y3464A Brand New $75.00

CHOKES

25 HY 4 amp. 5 ohm DC resistance. 20,000 V test GE 6R6455 Brand New $24.95

1HY 3.2 amp DC 3.5 ohm GE 6R6455 Brand New $34.95

GENERATOR VOLTAGE REGULATOR

115 volt 400 cycle GE GBA 26C Now $10.95

ALUMINUM MAST

76 feet telescopic aluminum mast fully collapsed only 11 ft. Dia. at base 7", tapers to 3½" at top—with guys, erection poles and lights. $175.00

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12 VDC DPST Box 32 ..$ .65
24 VDC Solenoid operates two Switchetts 1.25
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110 VAC DPDT 2.95
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115 VAC DPST S-D CXA 2997 ..... 2.75
220 VDC DPDT S-D CX 2122 ..... 3.09
230 VAC DPDT GE 12HGA111A1 enc. in bakelite case 4.25

ROUND PANEL METERS
.5 Volts RF Output 50 Micro Amp. Weston 2½" $4.75

0-4	RF	Amps	GE	3" 3.95
0-5	RF	Amps	Weston	3½" 4.50
0-300	MA	DC	Simpson	2½" 3.75
0-300	MA	DC	Westing	2½" 3.75
5-0-5	MA	DC	Weston with 50 MA shunt	3½" 4.25
0-8	Amps	DC	McClin	2½" 1.95
0-50	Amps	DC	Weston	3½" 6.75
0-100	Amps	DC	Hoyt	3" 3.00
0-15	Volts	AC	GE	3½" 4.95
0-5	Volts	DC	Sun	2" 1.95
0-2500	Volts	DC	Simpson with 2500 Volt Multiplier	3" 5.95
0-5	KV	DC	0-10 MADC	3½" 5.75
0-150	Volts	DC	Hoyt	3½" 3.95
10-0+6		DB	Weston	2½" 4.50

PORTABLE METERS

0-10	m	DC	Weston	489 7.50
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NAVY RDF RECEIVER

Fixed tuned freq. range 200-850 KC operates on 110 VAC. Brand new w/ speaker and spares $39.95

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1 minute 115 VAC 60 cy Enc. in water-proof metal case ..... Now $2.95
3 micro switches make contact at 40-41-42 sec. time delay 110 VAC motor Now $4.00
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Thermo switch 50°F to 300°F. 115VAC @ 6A, 230VAC @ 3A. Breaks contact with increase in temperature Now .95

TUBES

2C34	.25	CK-1005	.20
2X2A	.55	CK-1007	.90
2X2/879	.35	1626	.25
3C24	.88	1629	.25
7C4/1203A	.35	2051	.60
10Y	.45	7193	.20
15E	1.20	8011	2.00
15R	.60	9002	.30
29-44	.25	9003	.35
45 Spec	.28	9006	.25
HK54	1.65	C5B	6.90
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213A	.90	CK-76	3.50
717A	.55	E-1148	.35
801A	.25	HY615	.70
803	4.00	RK-73	.75
804	8.50	VT-127A	2.25
805	3.65	VT-1	.50
826	.40	3BP1	2.50
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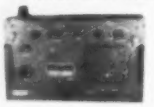

I-222-A RF SIGNAL GENERATOR

Covers two bands—8-15 mc., 150-230 mc. Can use up to third harmonic. Built-in 110 V., 60 cycle power supply. In good condition. $77.00

I-122 Sig. Gen., 15-28 mc., 85-130 mc., with built-in pwr. supply, good condition $77.00

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UHF generator. Has range from 8-330 mc. In good condition. A real buy at this price $177.00

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An excellent precision instrument. Good condition $125

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Complete with self-contained power supply and power cord. Tunes 40-500 Mc. with usable harmonics up to 3000 Mc. In good used condition. A real precision instrument priced well below its original cost.

$125.00

TS 164/AR FREQUENCY METER

Airborne version of BC-221. With original calibration book.

$75.00

TS-10/APN	$40.00
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BC-678A RELAY UNIT
RM-25A CONTROL UNIT
RM-26A CONTROL UNIT
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PM FIELD DYNAMOTOR POWER SUPPLY—Completely filtered. Has two PM Dynamotors as listed directly above $5.00

WRITE TODAY FOR QUOTATION ON OTHER DYNAMOTOR OR INVERTER NEEDS!

GENERATOR—12 Volt 100 Amp. Mfg. by Emerson. 3400 R.P.M. with ⅝" x ⅞" shaft and 4 mtg. holes on each end for right or left. Motor size: 8⅝" x 4⅜". Price $12.95

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MP-132—1" heavy coil spring, 2" insulator. Overall length 11⅛". Weight: 2¾ lbs. Price $3.96
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BAG BG-56 for carrying 5 mast sections ..... 50¢ ea.

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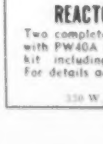

Ideal reversible motor for rotating antennas, displays, etc. (Similar to illustration.) Weight: 4 lbs. Overall size: 9" long, less shaft. Gear Box size: 3⅛" x 3⅛". Motor size 4" x 2⅛". Shaft size: ⅜" x 1⅛" threaded. Operates from 24 volt DC, 2.0 A., 9 R.P.M. or 28 volt AC at 75 lbs. torque per inch. Price $5.95
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RHEOSTAT to control speed. 120 ohm, 50 Watts ..... 97¢

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Hermetically sealed matching Transformers, primary 800, Secondary 5,000 Price ..... 3 for $1.25

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100 Magnetrons	4Y38	
1,000	5D21	10.00

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TYPE	SEC. V	MA.	FILAMENTS	MTG.	PRICE
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T-40352	1100 CT	275	5V @ 3A CT; 5V**	GGV	$3.50
	650 CT	75	6.3V @ 6A		
T-40378	700 CT	145	6.3V CT @ 5A 5V @ 3A	GGV	$1.50
T-40511	580 CT	50	5V @ 3A 6.3V CT @ 2A	AGF	$1.25
T-40513	700 CT	90	6.3V CT @ 3.5A 5V @ 3A	AGF	$1.50
T-40514	700 CT	120	5V @ 4A 6.3V CT @ 4.7A	AGF	$1.25
T-41240	740 CT	280	5V @ 3A 6.3V CT @ 7A	GGV	$1.95
T-41276	—	—	6V @ 3A *7.5V @ 6A	GGV	$1.49
T-48486	700 CT	160	5V @ 3A 6.3V CT @ 4A	GGV	$1.50
T-49831	400	225	—	GGV	$2.25
	750	100	—		
T-49837	—	—	5.1 CT @ 13A	CAV	$1.35
T-40504	700 CT	90	5V @ 3A 25V CT @ 12.5A	AGF	$1.50

** @ 2A CT *Tapped at 5 and 6.3 volts.

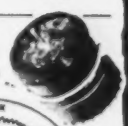
Power Transformers 115/1/60 Input

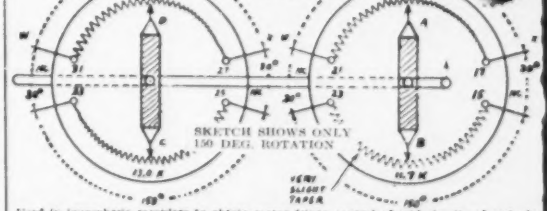
TYPE	SEC. V.	MA.	FILAMENTS	MTG.	REG. PRICE	SALE PRICE
T-40411	550 CT	50	5V @ 3A 6.3 CT @ 2A	AGF	$4.20	$1.95
T-40415	750 CT	150	6.3 CT @ 5A 5VCT @ 4A	AGF	6.26	2.79
T-40417	600 CT	60	5V @ 3A 2.5VCT @ 7.5A 6.3VCT @ 2.5A	AGF	5.13	1.95
T-45101	684 CT	130	5V @ 3A 6.3VCT @ 2.5A	AGF	6.00	2.75
T-44824	700 CT	115	5V @ 3A 6.3VCT @ 1.5A	AGF	5.39	2.25
T-43060	700 CT	120	5V @ 4A 6.3VCT @ 4.7A	*	6.00	2.95
T-49815A	760 CT	150	5V @ 2A 5V @ 2A	AGF	6.26	2.50
T-50321	510 CT	70	6.3V @ 2.25A 6.3V @ 2.25A	AGF	5.00	1.95
T-50684	580 VCT	120	5V @ 2A 6.3V @ 2A 5V @ 4A	AGF	5.70	1.95

*Hermetically sealed

WESTERN ELECTRIC PRECISION POTENTIOMETER TYPE D-16909

ONLY **$12.50**





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BAV	2-7/8	1-3/4	2-9/6
CAV	2-1/2	2-1/4	3-1/16
FGV	2-7/8	1-7/8	2-9/16
GGV	2-7/8	3-1/4	3-1/2
RTV	1-9/16 dia.		3

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310A	.35	724B	2.50
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701A	3.50	846	47.50
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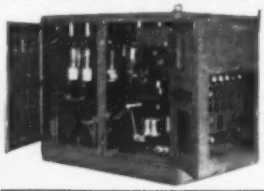

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Works from 110 volts A.C.

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Includes 2 Amplifiers, 2 Signal Generators, complete with Cabinet, Spare Parts and Transmitter Control Station, which consists of Microphone, Speaker Group Selector and Volume Indicator

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Waterproof Construction, 12 inches.

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8-HEAD MACHINE, for button stems.

TUBE STEM MACHINES Mfd. by Kahle Eng. Co. 4-5-6-7-8 positions with Geneva movements.

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EXHAUST MACHINE 32 head, capacity 60 tubes per hour, 80 W. type B174 Seallex chassis.

VACUUM FIRING EQUIPMENT Mfg. by GE.

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EXHAUST MACHINE 16 head, mfd. by GE, can be converted to standard tube production.

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High shock rheostats, four 13" plates, 100 ohms @ 2A, 175-345 V connected in series. Assembled for back of board mtg. or by reversing the supporting brackets for floor or table oper. New $19.75

RETARD CHOKE COILS

American Type Line voltage 15,000; ripple freq. 120. Oil-filled. 920A DC @ 200H @ 48% ripple. 52A DC @ 2.5H @ 48% ripple 17"x17"x22" w/term. 10" above base. 40°C temp. rise $34.00

MILLIAMMETERS

150-0-150 MA DC. Accuracy ½ of 1%. Scale length 4¼". Wt. 3½ lbs. 6" x 2½" x 4¼". Like New $2.50

SPERRY A-5 VERTICAL GYRO UNIT

#644841. 115 V. 400 CY 3 phase. Contains gyro assembly, erection motor, erection relay assembly, pick-off assembly, elevator and aileron limit switches, and roll axis. 15 x 12 x 9. New $27.50

QBE-1 Underwater Sound Equipment

Type CBM 55681 Indicator Unit—Ranges 0-1000 yds. and 0-5000 yds., Visual & Audio Indication Synchronous motor driven, input 115/1/60. 20 x 16 x 8½ $25.00

BATTERY CHARGER

Ideal for your car, for the serviceman and ham. Selenium—transformer type. 7½ x 4½ x 4½. Portable metal container. Input 115, VAC output 6.5 V @ 2 amps $7.25

DIEHL MOTORS

Normally 110V, 60 cy. 3 ph. units. Will operate satisfactory on 110V, 60 cy. with addition of cy. capacitors across one of the other phases. 1/40 HP, cont. duty, 2450 RPM. 1⅝" x ⅜" D shaft. Motor dimensions: 4" H x 3"W x 3"D. Wgt. 10 lbs. $5.50

AUTOSYNS, INVERTERS AND DYNAMOTORS

PE 206-Inverter, input 27 Volts DC, output 80 Volts, 800 Cycle 200 Va. $10.00
PE 218 Inverter, input 27 Volts DC, output 115 Volts, 400 Cycles. 1500 VA Rebuilt. L.N. 15.00
G. E. Dynamotor, 5D48H8A input 14 V. D. C. output 1000 V. at 350 Ma. with filter 5.00
MG-132A Inverter: input 24 VDC, output 140 V AC, 1.2 Amps. 350 cy. 1800 RPM 100% PF. 19.95
AY—1 Autosyn indicator 26 V. 400 Cy. 400 AY—14 Trans. Autosyn 26V 400 Cy. new calibration chart 10.95
AY—20 26 V Trans. Autosyn 26 V 400 Cy. 6.50
ANSO ANTENNA. ¼ Wave length trans. receiving 500 MC 2" Blade Type Mdlg. in bollanite form. ..... 75¢

CHOKES AND TRANSFORMERS

Raytheon S. M. Chokes, UX7776, 1.28 Henries 150 MA @ 7 ohms ..... $ 1.75
Raytheon S. M. Choke, #X8678. 15 Henries 25MA 1050 ohms ..... .50
Raytheon S.M. Choke, UX9116, .03 Henries 2A (Rectifier Choke 2.25
Raytheon Choke Assembly, CRP30509, 1.8 Henries @ 0.38A 1.50
Raytheon Dual Choke, WX5146, 1.5 Henries 400 MA 1.5 Henries @ 400 Ma. 1.95
Raytheon S. M. Choke, (Rectifier) UX9114A, 0.100 Henries 1.4 Amps. 2.00
G. E. #7585576, 87.9 Henries @ .0672 Amps. 7.5 KV Pk. Test Volts 10.00
American, 20 Henries @ 45 MA. ..... .75
Sprague, 15-84-91-400-50P 4.95
Kast, 15 E-5-1-33-700-50*2T (Z1743) 3.00

Raytheon, UX7561A, blocking oscillator, 3 windings, 2-3 micro seconds, peak pulse 300-400. Repetition rate up to 4000 Cy. 1.75
Raytheon, Input, UX9216A, Pri. 10,600 ohms impd. Sec. 2x 25,000 ohms 1.00
Raytheon 80-cy, UX8725A, Pri. #1 1600-0-1600 turns. Sec. #2 800-0-800 turns. Sec. #3 & #4 1600 turns 1.00
Raytheon, Auto, UX7548, Pri. 26V Sec. 10.5V 400-800 cy. 1.00
Raytheon, Interstage, UX7587C. Pri. #1 & #2 15,000 ohms impd. Sec. #7 .500 ohms 1.00
Raytheon, Phasing UX8724. Pri. 115 VAC. 60 cy. Sec. 15V 0.8MA 1.25
Raytheon, Interstage, UX8442. Pri. Minus 40V Sec. plus 40V 1.00
Raytheon AC RC UX7858, Pri. 115 VAC 400 Cy. Sec. 6500V, .005A 2.50
Raytheon Filament UX8486A, Pri. 115 VAC 400 Cy. Sec. 5V @ 5A, 12500 WVT. 1.50
Raytheon, Output UX7489A. Pri. 3000 Ohms Sec. 720 Ohms 1.25
Raytheon Plate & Fil. UX8347. Pri. 115V 400 Cy. Sec. 1000V 25MA. Sec. #2 6.15 V 0.7A 1.95
Raytheon Pulse Transformer WX5127. Pri. 4 KV. 1 MC. Sec. 16 KV 16 Amps. Fil. Trans. Pri. 115V 60 Cy. 3.95
Raytheon Fil. Type U-8370 Uri-220/440 60 Cy. Sec. #1, #2, #3 2.5 Volts @ 4 Amps. Sec. #4 2.5 Volts @ 15 Amps. 2 KV Test 6.50
Raytheon Dist. Type CRP-30582. Pri. 220/440 V 1.71 A. Sec. 145 V @ 0.53 A. 4000 V T. 14.50
Raytheon Fil. U-5083 Pri. 220/440 V 60 Cy. Sec. 5 Volt @ 30 Amps. 1780 test Volts 14.50

YJ RADIO EQUIPMENT. Two Channel, automatic responding Radar Beacon or Racon. Designed for shore installation. Automatically transmits coded signals in reply to interrogating signals from craft equipped with radar or IFF equipment. Replies to interrogating signals in the (A) Band 176 MC, (B) Bank, 515 MC. Rectifier power unit; A and B Band transponders, transmitter and receiver complete with 20 tubes. 115/1/60 26" L. 8" H. 17" W. Wgt 270 lbs. LN. Price $665.00

HOT SPECIALS—CONDENSERS—Standard Brands
2x50 MFD @ 150 WVDC TUBULAR ..... @ 50¢
40 MFD @ 200 WVDC TUBULAR ..... @ 35¢
16 MFD @ 150 WVDC TUBULAR ..... @ 20¢
.1 MFD @ 600 WVDC TUBULAR ..... @ ea. 15¢
.25 MFD @ 600 WVDC OIL IMPREG TUBULAR CAN 481074 17¢ ea.; 10 for $1.50
Same as above but 400 volt 15¢ ea.; 10 for $1.35
.01 MFD @ 6KVDC PAPER TUBULAR HERM. SEALED 10¢ ea.; 10 for $1.50
RAYTHEON DEFLECTION COILS. #US820 for 5FP7, CRT. Metal Cased $1.85
COMMAND SET EQUIVALENT—BC 430, Excellent VFO using 2 Type 45's and 2 Type 10 tubes, 40 WATTS CW with one coil. 4 COIL RANGES: 2 - 2.5, 2.5 - 3.2, 3.5-6, 3.6 - 4.5, 4 - 4.8, 6 - 7.5, and 7.3 - 9 MC. Your choice of coil $8.95
COMMAND TRANSMITTERS 2 - 3 MC, LN $7.95. 3 4 MC LN $12.95. 4 - 5.3MC LN $7.95. 5.3 - 7 MC LN $7.95.
SCR 178—TRANSMITTER RECEIVER 2400-3700 KCS 10 W OUTPUT w/spare parts PHONE AND CW opr. $45.00
RL-42B ANTENNA REEL—w/MOTOR AND GEAR BOX—Perfect Beam rotators. Wt. 4 lbs. magnetic clutch. Reversible with SPDT switch $3.95
"BEAM INDICATOR" SELSYNS—GE model 2J1G1. Operates from 57.5-57.5 V. 400 cy w/wiring diagram for 110 V 60 CY oper. $2.50 pair. Also available GE Model 2J1F1 115-115 V 400 cy ..... pair $3.50
ANTENNA CHANGE OVER SWITCH—SPDT. Knife operated. Heavy duty. Isolantite insulation ..... 39¢
HEAVY DUTY AIR COOLED RESISTORS .52 ohms or 10 ohms 1000W. Your choice $1.50
REMOTE CONTROLS. RM29A Telephone Units, no ext. power nec. Good up to 50 miles, self contained Magneto ..... pair $17.95
CALROID HEATERS GE #5A760 115V 200W. $1.50
GE 5A699 65W 57.5V ..... 75¢
G.E. FUSE HOLDERS TYPE EL-1. Neon lamp indicating Midget size #6278724G1, 12A ..... 49¢
G. E. 6227889G1, 60A ..... 69¢
TRANSMITTER AND RELAY RACK CABINETS—Chrome decorated hinged door on top and back with catch. Amateur or W.E. method. Black crackled 28½" H. 18" D Panel space 28½" LN $10.00 ea.; 2 for $17.50
WESTERN ELECTRIC PRECISION CRYSTALS. 40 Meter Band 7270 KC. 95¢ ea. 2 for $1.75
25' EXTENSION LIGHT heavy duty cord. Switch on handle. Metal bulb protector $1.65
HEINEMAN CIRCUIT BREAKERS—24 VDC @ .220 A., SPST. 95¢ ea.; 6031 M-10, 24 VDC @ 10 A., SPST $1.45, 6032M 10-24 VDC @ 15 A. DPDT $2.25
GUYWIRE—1/16" Dia. Galv. Perf. Steel. Excellent elasticity. Rust proof. Ideal for TV antenna installations. 1000 ft. coils $3.00/M
FRACTIONAL HORSE POWER MOTORS—OSTER 27.5 VDC 1/20 HP 3600 RPM SHUNT Wound $7.95
UNIVERSAL, ELECTRIC 115 VDC. 12 AMPS .093 HP 5000 RPM $4.50
OSTER 6 VDC 1.8 AMPS 5000 RPM 6 oz./in. torque W. BLOWER Size 1½ AND IMPELLER $4.50
EMC 110 VAC 60 cy. 1/40 HP 1725 RPM. LN. $4.50
OSTER 27.5 VDC/100 HP Series 7000 RPM $2.50
UNIVERSAL ELECTRIC 28 VDC. 0.6 AMPS 5000 RPM 1/100 HP $2.50
EMERSON 27.5 VDC 24 AMPS. Series wound. 1/8 HP 160 OZ FT torque $7.95
GE 27VDC 5 AMPS 250 RPM 8 OZ/IN LN $3.50
PHONO MOTORS—GENERAL IND 115 V 60 cy. 80 RPM Minus Turntable $2.50
CHOKES—2.5 H @ 700 MILS. 14 OHMS $5.95
20 HENRIES @ 45 MILS, 500 OHMS ..... 60¢
40 HENRIES @ 20 MILS ..... 80¢
150 HENRIES @ 1 MIL, 7,000 OHMS ..... 45¢
TRANSFORMERS—Pri: 115 V 60 Cy.
THORDARSON (20R62) 350-0-350
145 MILS .5V @ 5 A, 6.3 VCT @ 4.5A $4.25
JEFFERSON P1L—20 Volts @ 10 A $3.95
OPEN CORE POWER, 18 V @ 6 A $2.95

STANDARD BRAND CAPACITORS

Interleen type FL, 7500 VDC 135 MFD. 13.5 Meg. resistance. Style 1227191-A. Precipitron Service. New $6.95
Synchro Capacitor Cat. #23F613. Rated at 90 volts 3 ph. 60 cy., 30 Mu-f. New $4.95
Cat. #14F201. Rated at 16-8 KV, .375-.75 Mu-f. New $9.95
Bathtub #42306. Rated 5-3-1-1 Mu-f., 150 VDC. New $1.00
Fast High Voltage type AE6734. Rated 1.0 Mu-f. 25 KV. Oil-filled. New $60.00
Cat. #23F774. Rated 0.1-0.1 Mu-f. 7000 VDC $2.95
Motor Starting Capacitor #8325784-1. Rated 2 x 100 Mu-f. 150 VDC. New $2.90
Fast High Voltage Oil Filled #A7548. Rated at 0.25-0.25 Mu-f. 6-12 KV. New $14.96
Mica type PL1150-30H. Cap. 0.115 mfd. 2000V. 15A @ 3000 KC, 20A @ 1000 KC, 29A @ 300 KC. New $3.95

TRANSTAT VOLTAGE REGULATORS

American type RH. Input: 115 V. 400 cy. 0.5 KVA, 5.5 max. amps. Output: 92-115V, 5¾x14⅝x23¼. $1.98

0.25 KVA Fixed winding 115/1/60. Commutator range 103-126 V. 2.17 Max. Amps. $9.45

DECK ENTRANCE INSULATORS

(Bowl and Flange Type)

Mfd. by Ohio Brass Co. heavy galv. metal flange 10½" D., porc. bowl set in rubber gaskets. Top bell 7¼" D. brass feed thru rod 10½" L. Insul. dist. between top bell and flange 6⅛". $3.50

DYNAMOTOR GENERATOR

Model 3975-1. Electric Spraph Co., prof "Gibson Girl". Input 28 VDC @ .75 amps. Output 300 VDC @ .060 amps. 5" L. 5¼" D. ..... $1.00 ea.

SELECTOR SWITCHES

Heavy duty, U. S. N. Control any type of multi-circuit devices. Removable contacts enabling any comb. of closed and open circuit. The following available: 5 section-10 pole or 10 section-20 pole. $1.50 ea. Case lots of (8) $8.00 or (5) cases, special $32.50

MINE DETECTOR SCR 625

Detects metallic objects (ferrous or non-ferrous) to a depth of approx. 6 ft. Fixed or outboard motors on the bottom of lakes, locate underground piping, treasure, metallic fragments in lumber, etc. New, complete with inst. book, $65.00. Used but like new $49.00

B. C. 604 F. M. TRANSMITTER

Wide or narrow band FM. 30 watt power output. Excellent possibility for ten or eleven meter exciter. Freq. 20-27.9 MC. Working space permits modification. W/tubes but less power supply and xtal with LN $11.50. Complete with Crystal. $25.00

NEW SWITCH INTERLOCKS

B857 B956 B1536

Cory Type B857. Single Key Oper. Interlocking of doors, vaults, reactor or resistor enclosures, oil circuit breakers, etc. $1.98
Cory Type B956, Single Key Oper. SPST 8W w/Yale Cyl Lock 60A tumbler lock $2.49
Cory Type B1536, Supervisory Oper. 2 key type. $2.98

DELCO CONSTANT SPEED MOTOR

Type A-7135, 27 VDC, 2.4 A 1/30 HP. 3600 RPM. 2½" Diam. x 5½ L. ⅜" Sh. Ext. Cont. Duty. Base mounted ..... $4.25 ea.

VIBRATOR POWER SUPPLY (PE 204A)

Used with Telephone Repeater EE-99A. Input 12 VDC. Output 2 windings @ 4.2 VDC @ 50 MA; 2 @ 45 VDC @ .5 MA. 2 @ 85 VDC @ 5 MA. Loaded with parts. New $1.95

WEST WATT HOUR METERS

Type CS, 240V/60cy/1ph 15 Amp., 3 Wire $12.50
Type CR, 120V/60cy/1ph 15 Amp., 2 Wire 9.10
Type CA, 120V/60cy/1ph 15 Amp., 2 Wire 9.50
HARDWARE BY THE POUND—Our assortment of screws, nuts, washers, cable clamps, lugs, spacers, springs, etc.
5 lb. assortment $5.00
25 lb. assortment $10.00

ALL PRICES F.O.B. BOSTON. ORDERS ACCEPTED FROM RATED CONCERNS ON OPEN ACCOUNTS NET 30 DAYS. MINIMUM ORDER $3.00

ESCO **ELECTRO Sales Co.**

399-405 ATLANTIC AVENUE Dept. E-5 BOSTON 10, MASSACHUSETTS LIBERTY 2-7890

"TAB" THAT'S A BUY TUBES
Tested—Guaranteed

0A5/VR75	$ 98	2C45/6046A	9.30	6AD7	1.17	6SN2GT	.89	12Q7GT	.55	48	1.56
0A4G	1.72	2C46	1.69	6AF4G	.77	6SN7WGT	.89	12S8GT	.79	50	1.49
0B2	1.72	2C51	1.69	6AG5	.84	6SQ7GT	.83	12SA7GT	.55	EF50	.40
0B3/VR90	.74	2D21	1.10	6AG7	.97	6SR7	.86	12SC7	.55	50A5	.73
0C3/VR105	.75	2E5	.89	6AH6	.80	6SS7	.92	12SF5GT	.54	50B5	.84
0D3/VR150	.75	2E22	1.15	6AJ5	.73	6ST7	.75	12SF7GT	.58	50C5	.89
0Z4	.56	2E26	4.50	6AK5	.80	6SU7GTY	.85	12SG7	.52	50C6	1.18
1A5	4.50	2E25 HY65	4.00	6AK6	.81	6SV7	.75	12SH7	.34	50L6GT	.52
1A7	.45	2E26	3.45	6AL5	.55	6T2G	.84	12SJ7GT	.54	50X6	.98
1A8	.46	2E30	2.95	6AL7	1.00	6T8	.82	12SK2GT	.51	50Y6	.65
1A6	1.00	2G5	.98	6AN5	1.08	6U5 6G5	.83	12SR7M	.52	53	.84
1A5GT	.48	2J21	11.45	6AQ5	.87	6U6GT	.89	12SL7GT	.54	57	.84
1A7	.53	2J31A	11.45	6AQ6	.84	6U7G	.48	12SN7GT	.47	58	.87
1A7GT	.63	2J32	9.75	6AR5	.84	6V6GT	.92	12SQ7GT	.45	59	.84
1B3 8016	.81	2J36	8.45	6AS5	.89	6V6GTY	.90	12SR7	.48	RK61	1.98
1B4	.98	2J37	14.50	6AS6	2.89	6V7G	1.15	NR74	.29	RK65	24.95
1B5 25S	.98	2J38	4.50	6AS7G	6.29	6V6M	.86	12Z3	.72	HY69	2.29
1B7GT	.98	2J52	14.85	6AT6	.68	6W4GT	.59	12AT7 12B7	.67	70A7	1.49
1B21 671A	2.85	2J53	18.95	6AU5	.53	6W7G	.87	14AF7	.56	210LT7GT	1.10
1B22	3.00	2J54	17.50	6AV6	.43	6X4	.52	14B6	.65	211	.65
1B23	9.00	2J55	14.85	6AW6	.69	6X5GT	.67	14B8	.72	215P4	.79
1B24	4.65	2J38	12.70	6BA6	.84	6Y5	1.85	14C7	.66	250	.84
1B26	6.50	2J39	29.00	6B6	.75	6Y6G	.65	14F8	.75	801	1.29
1B27	6.50	2J40	29.00	6B7	.89	6Y7G	.98	14H7	.63	FG81A	4.45
1B29	3.39	2J46	45.00	6B8G	.89	6Z7G	1.00	14J7	.63	82	.84
1B32 532A	2.75	2J49	22.50	6BA4	1.00	6Z8 12Z8	1.18	14N7	.86	82V	.95
1B37	45.00	2J50	39.00	6BA6	.40	6ZY5G	.67	14Q7	.55	83	.99
1B38	36.00	2J51	31.00	6BA7	.79	6AK5 XXL	.67	14R7	.65	83V	.89
1B41	49.95	2J61	39.00	6BD6	.69	7A5	.65	14X7	.98	84 6Z4	.56
1B42	.98	2J62	39.00	6BE6	.49	7A6	.65	15E	1.44	85	.57
1B43	49.95	2K28	23.75	6BF6	.52	7A7	.56	15R	.75	89	.32
1B54	49.95	2K36	24.89	6BG6G	1.39	7A8	.69	19AU4GT	3.98	VR92	.25
1B56	49.95	2K39	24.95	6BH6	.52	7AF7	.70	19BG6G	1.98	FG104	14.95
1C5	.86	2V3G	.49	6BJ6	.55	7AG7	.69	19T8	.98	FG105	10.75
1C6	.87	2W3GT	.98	6BQ6GT	.89	7B4	.55	20	1.17	VU111	.49
1C7G	.89	2X2	.36	6C4	.29	7B5	.70	20P1	.89	HY114B	.81
1D5GP	.98	3A4	.32	6C5	.45	7B6	.58	20P3	1.39	HY115-145	.80
1D7G	.84	3A5	.75	6C6	.52	7B7	.57	RK20A	6.98	117L7	1.23
1D8GT	.84	3B5	.98	6C8G	.63	7B8	.70	PJ31	4.98	117N7GT	1.36
1E5	1.05	3B7 1291	.79	6C7	1.26	7C4 1203A	.36	HY131	4.85	117P7GT	1.20
1E7G	1.00	3B22	2.64	6C8G	.65	7C5	.44	PJ21	4.98	117Z3	.49
1F4G	.75	3B24	1.75	6C21	23.95	7C6	.69	PJ22 CE1C	1.49	117Z6GT	.77
1F7GT	1.55	3B25	4.85	6CB6	.69	7C7	.65	24A	.60	117Z7GT	1.49
1G4GT	.69	3B28	5.39	6D4	2.75	7C23	69.00	24G 3C24	.45	FJ27A	16.95
1G5G	.98	3C23	3.98	6D6	.47	7E5 1201	.65	25A6	1.04	CV148	7.90
1G6GT	.61	3C45 C1B	2.75	6D7	.98	7E6	.87	25A7	2.98	155	.98
1H4G	.87	3C45	12.85	6D8	.73	7E7	.89	25L6GT	1.59	FG106	49.00
1H5G	.84	3D6 1299	.79	6E5	.69	7F7	.58	25B5	1.39	FG117	49.00
1H6G	.99	3D21A	.98	6F5	1.10	7F8	1.03	25B6	1.49	FG119	12.98
1J6G	.99	3E29 829B	7.98	6F6	.47	7G7 1232	.98	25C6	1.15	205B VT2	1.69
1J6	.72	3LF4	1.25	6F6GT	.52	7H7	.64	25B06GT	.98	211 VT4C	.42
1L4	.45	3Q4	.45	6F8G	.52	7J7	.98	25L6GT	.49	RK215	9.95
1L4AGT	.45	3Q5GT	.45	6F7	.80	7K7	1.05	25W4GT	.70	WE215A	.25
1LH4	.99	3S4	.84	6F8	.84	7L7	.67	25Y5G	.89	227A	2.90
1LC5	.84	3V4	.67	6G6	.99	7N7	.65	25Y5	1.05	231	1.20
1LC6	.75	4C33	81.00	6H6	.45	7Q7	.57	25Z5	.40	250TH	24.95
1LD5GT	.98	4C35	19.50	6J5	5.98	7R7	.63	25Z6GT	.47	250TL	24.98
1LH4	.64	4J31	95.00	6J6	4.65	7S7	.89	26	.42	282H	8.49
1LN5	.62	4J32	95.00	6J5GT	.57	7T7	1.03	FG27A	9.50	304TH	5.70
1N5GT	.59	4J42 700	29.85	6J6	.70	7V7	.85	28D7	.35	304TL	1.39
1N5G	.98	4J50	95.00	6J7	.65	7W7	.80	30	.49	307A RK75	3.60
1P5GT	.84	4T4 .2	9.95	6J7GT	.59	7X7 XXFM	.85	31	.49	316A	.49
1P28	.85	5C22	47.00	6J8GT	.95	7Y4	.44	32	.89	327A	2.70
1P35	.99	5C30 C5B	8.49	6K5GT	.79	7Z4	.55	FG32	4.95	350	1.23
1P35A	98.00	5D21	24.50	6K6GT	.42	10Y	.60	32L7GT	.53	350B	1.88
1Q5GT	.96	5J23	13.45	6K7	.48	12A6	.17	33	.65	355A	14.15
1Q26	75.00	5J29	17.39	6K8	.75	12A7	.96	FG33	8.49	368AS	3.75
1R4 1294	.65	5R4GY	99.00	6L5	.84	12AMGT	.48	34	.54	371B	.84
1R5	.59	5R4GY	1.05	6L6	.82	12AM7GT	.99	35	1.49	380A	.79
1S4	.96	5T4	.86	6L6G	.82	12AL5	.72	35A5	.65	388A	.89
1S5	.48	5U4G	.47	6L6GA	.82	12AT6	.43	35B5	.54	393A	.89
1T4	.48	5V4G	.58	6L7	.82	12AT7	.70	35C5	.54	394A	3.65
1T5GT	1.05	5W4	.66	6N4	1.08	12AU6	.52	35L6GT	.53	395A	3.65
1U4	.49	5X4G	.71	6N7GT	.90	12AU7	.62	35W4	.58	417A	4.95
1U5	.69	5Y3GT	.38	6P5G	.81	12AV6	.50	35Y4	.49	GL434	19.95
1V	.49	5Y4	.37	6P7G	.92	12AX7	.61	35Z3	.61	446A 2C40	2.90
1X2	.78	5Z3	.51	6P9	.57	12AW6	.55	35Z4GT	.49	446B	1.12
1Z2	3.98	5Z4	.74	6R8	.79	12BA6	.56	35Z5GT	.49	446H	1.50
2A3	.84	6A4	7.85	6S5	.85	12BA7	.75	REL36 6J4	.54	450TH	87.25
2AG	1.04	6A5	.98	6S6GT	.75	12BD6	.59	36	.61	450TL	49.95
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2A7	.78	6A7	.66	6SC7	.57	12C8	.85	39 44	.25	WL465	2.98
2B7	.78	6A8GT	.70	6SD7GT	.45	12E5	.98	CRC40	.54	CK506AX	1.29
2B22 GL530	.73	6AB4	.69	6SF5	.45	12F5	.55			RI1507	9.98
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Accurate Paper Tube Co 245
Accurate Spring Mfg. Co 158
Ace Engineering & Machine Co 227
Aeronautical Communications Equipment, Inc. 252
Aircraft Radio Corp. 196
Airpax Products Co. 150
Alden Products Co. 200
Allen-Bradley Co. 194
Allen Co., Inc., L. B. 258
Allied Control Co., Inc. 22
Alimetal Screw Products Co., Inc. 202
Altec Lansing Corp. 237
American Brass Co., Waterbury Brass Goods Branch 244
American Cancer Society 257
American Electroneering Corp. 177
American Gas Accumulator Co. 235
American Lava Corp. 43
American Phenolic Corp. 138
American Screw Co. 10
American Television & Radio Co. 256
American Time Products, Inc. 36
Ampex Electric Corp. 176
Andrew Corporation 42
Armo Corporation 38
Armco Steel Corporation 153
Arnold Engineering Co. 185
Art Wire & Stamping Co. 253
Astatic Corporation 206
Atlas Sound Corp. 228
Atomic Energy News, Inc. 258
Audak Company 292
Audio Devices, Inc. 127

Ballantine Laboratories, Inc. 148
Barker & Williamson, Inc. 196
Barrett Varnish Co. 258
Barry Corporation 62
Bead Chain Manufacturing Co. 166
Beaver Gear Works, Inc. 164
Belden Manufacturing Co. 39
Bell Telephone Laboratories 169
Bendix Aviation Corp.
Red Bank Division 175
Berkeley Scientific Co. 247
Bird & Co., Inc., Richard H. 245
Birtcher Corporation 253
Biwax Corporation 251
Blaw-Knox Company 145
Bliley Electric Co. 222
Boonton Radio Corp. 121
Borg Corp., George W. 252, 253
Boyce-Roche Book Co. 137
Bradley Laboratories, Inc. 56
Brand & Co., Wm. 211
Brentano's 135
Bridgeport Brass Co. 181
Browning Laboratories, Inc. 172
Burlington Instrument Co. 178
Burnell & Company 34

Cambridge Thermionic Corp. 256
Cannon Electric Development Co. 190
Capitol Radio Engineering Institute 241
Centralab, Div. Globe-Union, Inc. 11, 12, 13, 14
Cinch Manufacturing Corp. 113
Clarostat Mfg. Co., Inc. 227
Cleveland Container Co. 15
Cohn Corporation, Sigmund 233
Communication Accessories Co. 230
Condenser Products Co. 7
Consolidated Engineering Corp. 220
Continental Carbon, Inc. 255
Cornell-Dubilier Electric Corp. 37
Cossor (Canada), Ltd. 2 7
Coto-Coil Co., Inc. 214
Cruse Company, H. 258
Curtis Development & Mfg. Co. 245

Dano Electric Co. 243
Daven Company ..... Third Cover
Dial Light Co. of America 162
Distillation Products Industries 149
Dow Corning Corp. 258
Driver Co., W. B. 50
Driver-Harris Co. 51
Dumont Electric Corp. 213
Du Mont Laboratories, Inc., Allen B. 29, 209
du Pont de Nemours & Co., E. I. 147

Eastern Air Devices, Inc. 231
Eastman Kodak Co.,
Industrial Photographic Div. 123
Edison, Inc., Thomas A. 220
Eisler Engineering Co., Inc. 158, 258
Eitel-McCullough, Inc. 25
Electrical Reactance Corp. 49
Electro-Motive Mfg. Co. 2
Electro Products Laboratories 218
Electro-Voice, Inc. 219
Electronic Associates, Inc. 217
Electronic Instrument Co., Inc. 14
Electronic Measurements Co. 254

Electronic Tube Corp. 240
Electronics Research Publishing Co. 135
Enthoven & Sons, Ltd., H. J. 162
Erie Resistor Corp. 35

Fairchild Camera & Instrument Corp. 58, 174
Fairchild Recording Equipment Corp. 189
Falstrom Company 245
Federal Telephone & Radio Corp. 33, 153
Fidelity Chemical Products Corp. 174
Filtron Company, Inc. 9
Fisher Radio Corp. 140
Formica Insulation Co. 247
Fusite Corporation 61

General Ceramics & Steatite Corp. 216
General Electric Co.
Apparatus Dept. 8, 26, 27, 137, 151
Chemical Dept. 139
Electronics Dept. 35, 41
General Industries Co. 53
General Radio Co. 16, 17
G-M Laboratories, Inc. 249
Gramer Company 154
Graphite Metallizing Corp. 224
Grayhill 254
Green Instrument Co. 251
Gulton Mfg. Corp. 255

Handy & Harman 227
Hardwick, Hindle, Inc. 225
Hathaway Instrument Co. 215
Haydon Mfg. Co., Inc. 182
Haydu Brothers 51
Heath Company 164
Heiland Research Corp. 251
Heilpot Corporation 210
Hemingway & Bartlett Mfg. Co. 222
Hewlett-Packard Co. 45
Hudson Wire Co. 224
Hytron Radio & Electronics Corp. 165

Inductograph Products 257
Industrial Condenser Corp. 251
Instrument Resistors Co. 170
International Nickel Co., Inc. 173
International Rectifier Corp. 235
International Resistance Co. 4, 5
I-T-E Circuit Breaker Co. 203

Johnson Company, E. F. 176
Jones Div., Howard B., Cinch Mfg. Corp. 292

Kahle Engineering Co. 239
Karp Metal Products Co., Inc. 23
Kellogg Switchboard & Supply Co. 241
Kenyon Transformer Co., Inc. 33
Kester Solder Co. 117
Kinney Manufacturing Co. 46
Kollsman Instrument Div.,
Square D Co. 179

Lambda Electronics Corp. 253
Lampkin Laboratories, Inc. 258
Lavoie Laboratories 139
Leach Relay Co. 144
Lectrohm, Inc. 229
Legri S Company, Inc. 216
Leland, Inc., G. H. 174
Lewis Engineering Co. 154
Lewis Spring & Mfg. Co. 146
Linde Air Products Co., Unit of Union Carbide & Carbon Corp. 232
Littelfuse, Inc. 176
Lord Mfg. Co. 212

Macmillan Company 134
Magnecord, Inc. 183
Mallory & Co., Inc., P. R. 64, 115
Marion Electrical Instrument Co. 237
MB Manufacturing Co., Inc. 187
McGraw-Hill Book Co. 135, 136
Measurements Corp. 233
Microscope & Lens Co. 258
Millen Mfg. Co., Inc., James 250
Milo Radio & Electronics Corp. 242
Miniature Precision Bearings, Inc. 258
Minneapolis-Honeywell Regulator Co., Industrial Div. 6
Minnesota Mining & Mfg. Co. 228
Mitchell-Rand Insulation Co., Inc. 24
Mosinee Paper Mills Co. 186
Muirhead & Co., Ltd. 2
Murex, Ltd. 178
Mycalex Corp. of America 207

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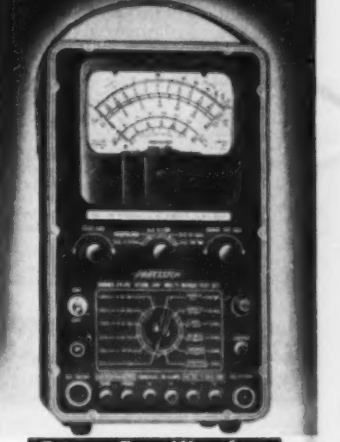

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National Company, Inc. 231
National Moldite Co. 236
National Research Corp. 157
National Varnished Products Corp. 143
New Hermes 255
New York Transformer Co., Inc. 188
Ney Company, J. M. 166
North American Philips Co., Inc. 176
Nothelfer Winding Laboratories 257

Oregon Electronics Mfg. Co. 150

Painton & Co., Ltd. 220
Panoramic Radio Products, Inc. 237
Paper Machinery & Research, Inc. 250
Paramount Paper Tube Corp. 233
Park Metalware Co., Inc. 243
Peerless Electrical Products Div., Altec Lansing Corp. 178
Phalo Plastics 162
Philamon Laboratories 146
Plastics & Electronics Co. 258
Polarad Electronics Co. 166
Polytechnic Research & Development Co., Inc. 141
Potter Instrument Co., Inc. 222
Precision Apparatus Co., Inc. 291
Precision Paper Tube Co. 150
Premax Products Div. Chisholm-Ryder Co., Inc. 257
Presto Recording Corp. 234
Pyramid Electric Co. 60

Radio Corp. of America 180, 205, Fourth Cover
Radio Receptor Co., Inc. 139
Railway Express Co., Air Express Division 226
Raytheon Manufacturing Co. 125
Reeves Hoffman Corp. 156
Remler Co., Ltd. 248
Revere Copper & Brass, Inc. 44
Rider Publisher, Inc., John F. 134
Rogers Corporation 52

Sarkes Tarzian, Inc. 60
Scientific Electric Div. of "S" Corrugated Quenched Gap Co. 154
Scintilla Magneto Div., Bendix Aviation Corp. 18
Scotil Manufacturing Co. 218
Servo Corp. of America 231
Shallcross Manufacturing Co. 142
Sigma Instruments, Inc. 63, 216
Simpson Electric Co. 54
Smuckler & Co., Inc., A. F. 47
Sonar Radio Corp. 158
Sorensen & Co., Inc. 30, 31
Sound Apparatus Co. 235
Specialty Battery Co. 249
Spellman Television Co., Inc. 255
Sperry Products, Inc. 216
Sprague Electric Co. 119
Stackpole Carbon Co. 28
Standard Piezo Co. 218
Standard Pressed Steel Co. 170
Staver Co., Inc. 249
Steward Mfg. Co., D. M. 257
Stoddart Aircraft Radio Co. 40, 155
Struthers-Dunn, Inc. 160
Stupakoff Ceramic & Mfg. Co. 168
Superior Electric Co. 191
Superior Tube Co. 201
Surprenant Mfg. Co. 161
Sylvania Electric Products, Inc. 131, 199

Tech Laboratories, Inc. 224
Technology Instrument Corp. 208
Tektronix, Inc. 248
Telechron, Incorporated 197
Television Equipment Corp. 253
TEL-Instrument Co., Inc. 192
Terpening Co., L. H. 221
Thomas & Skinner Steel Products Co. 229
Titeflex, Inc. 249
Topflight Tape Co. 258
Transradio, Ltd. 239
Triad Transformer Mfg. Co. 239
Triplett Associates 243
Turner Company 19

Union Carbide & Carbon Corp., The Linde Air Products Co., Unit 232
United Transformer Co. Second Cover
Universal Winding Co. 171

Vartlex Corporation 48
Veeder-Root, Inc. 195
Vickers Electric Division, Vickers, Inc. 184, 233
Victoreen Instrument Co. 223

Ward Leonard Electric Co. 152
Ward Products Corp. 238
Waterman Products Co., Inc. 170
Webster Electric Co. 194
Weller Manufacturing Co. 241
Westinghouse Electric Corp. 29, 21, 167
Weston Electrical Instrument Corp. 163
White Dental Mfg. Co., S. S. 204, 243
Whitehead Stamping Co. 241
Whitney Metal Tool Co. 249

■

PROFESSIONAL SERVICES 259

■

SEARCHLIGHT SECTION
(Classified Advertising)

EMPLOYMENT
Positions Vacant 260, 261
Selling Opportunities Offered 261
Positions Wanted 260
Selling Opportunities Wanted 260
Employment Services 260

SPECIAL SERVICES
Contract Work 260

BUSINESS OPPORTUNITIES
Offered 260

NOTICES
Proposal 260

EQUIPMENT
(Used or Surplus New)
For Sale 262, 290

WANTED
Equipment 280, 281

ADVERTISERS INDEX

Alvaradio Supply Co. 280
American Electrical Sales Co. 288
American Sales Co. 286
Arrow Sales 275
Bell Aircraft Corp. 261
Belz 286
Blan 280
Brooks Co., Inc., B. D. 283
C. G. S. Laboratories, Inc. 288
Columbia Electronics, Ltd. 279
Communications Devices Co. 284
Communications Equip. Co. 262, 263, 264
Cottone & Co., A. 282
Dubin Electronics Co., Inc. 282
Electro Impulse Laboratory 279
Electro Sales Co. 289
Electronic Engineering Co., of Calif. 261
Electronicraft, Inc. 273
EPCO 288
Fair Radio Sales 286
General Precision Laboratory 261
Goodyear Aircraft Corp. 261
Gould Green 286
Haydu Brothers 288
Horlick Co., William I. 268, 281
Hughes Aircraft Co. 261
Instrument Associates 266, 267
Joseph Radio Parts Inc., Irving 280
Kay Electric Co. 261
Klein, Manuel 283
Lectronic Research Laboratories 274
Legri S. Co., Inc. 281
Liberty Electronics, Inc. 284, 287
Life Electronic Sales 276
Maritime Switchboard 265
Mogull Co., Inc., Alexander 282
Monmouth Radio Laboratories 280
Neomatic Inc. 285
Opad-Green Co. 283
Peak Electronics Co. 270
Phadick Sales Corp. 288
Poly-Tech N. Y. 278
Precision Electrical Instrument Co. 284
Radio Ham Shack, Inc. 269
Radio Shack Corp. 287
Reliance Merchandizing Co. 277
Raytheon Mfg. Co. 283
Servo-Tek Products Co., Inc. 273
Soundtronics Laboratories 285
TAB 290
Technical Index Service 260
Teletronics Laboratory Inc. 269
Titeflex, Inc. 281
United Surplus Materials 278
Universal General Corp. 283
Weston Laboratories 285
Wells Sales Inc. 271
Wilgreen 285

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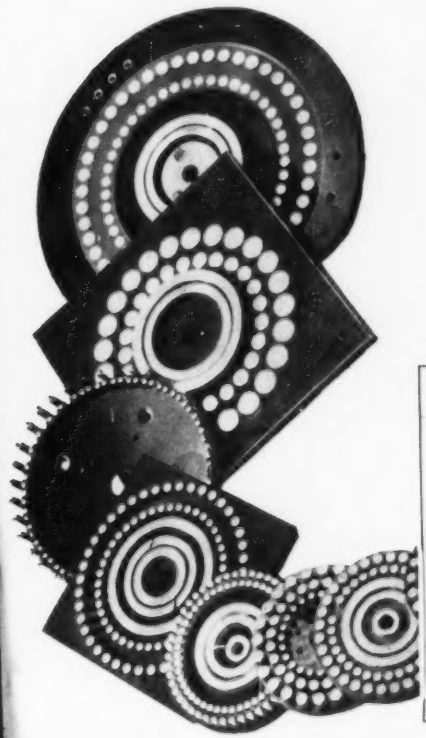

Type	Operation	Maximum No. of Positions (per pole)	Maximum Poles per Deck	Deck Size
C1A	make before break	31	1	1 3/4"
C2B	break before make	15	1	1 3/4"
C7A	make before break	11	2	1 3/4"
C8A	break before make	5	2	1 3/4"
D1A	make before break	47	1	2 1/4"
D7A	make before break	14	4	2 1/4"
D9A	make before break	9	5	2 1/4"
D10B	break before make	5	5	2 1/4"
E3A	make before break	47	2	2 3/4"
E4B	break before make	23	2	2 3/4"
E7A	make before break	23	4	2 3/4"
E8B	break before make	12	4	2 3/4"
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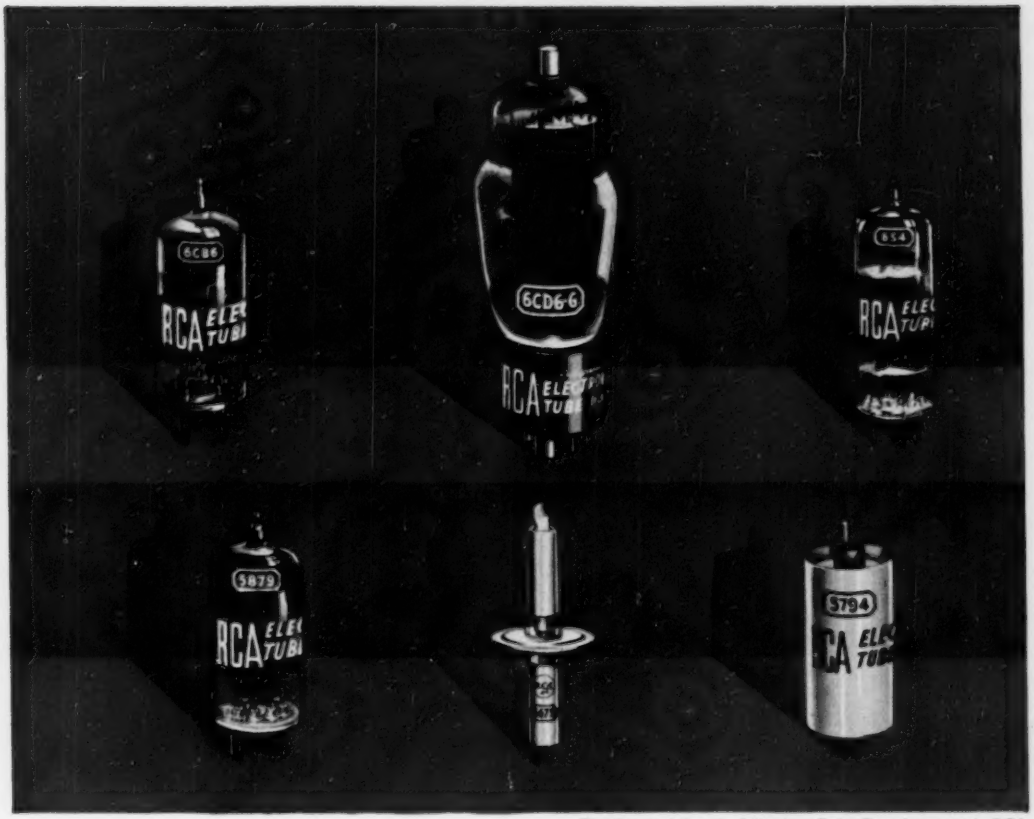

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RCA-6CD6-G Horizontal-Deflection Amplifier. For 16GP4 systems, and for other similar wide angle systems, it makes possible the design of efficient horizontal-deflection circuits in which the plate voltage for the tube is supplied in part by the circuit and in part by the power supply.

RCA-6S4 Vertical-Deflection Amplifier. A high-perveance miniature triode of the heater-cathode type. In suitable circuits it will deflect fully a 16GP4 or similar kinescopes having a deflection angle of 70 degrees and employing an anode voltage up to 14,000 volts.

RCA-5879 Sharp-Cutoff Pentode. Of the 9-pin miniature type, the 5879 is designed for a-f applications where reduced microphonics, noise, and hum are essential. It is especially useful in the input stages of medium-gain amplifiers.

RCA-5675 "Pencil-Type" Triode for UHF. Employs double-ended coaxial-electrode structure, for use in grounded-grid circuits. As a local oscillator, it will deliver 475 milliwatts at 1700 Mc. and about 50 milliwatts at 3000 Mc.

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For data on any of the tubes described above, write RCA, Commercial Engineering, Section E42R, Harrison, N. J.

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